SECTION 23 73 43 19 – OUTDOOR CUSTOM AIR HANDLING UNITS

PART 1 GENERAL

1.1 DESCRIPTION

A. This standard covers the design, performance, fabrication, testing, cleaning and packaging, shipping, installation and final assembly of custom built-up air handling unit.

B. The details outlined and component manufacturers named in this specification are not absolute. However, any deviations from this standard must be specifically identified with potential cost savings to the customer and explanations of how the deviation creates a product that meets or exceeds the design intent of this standard.

C. This standard is to be used for labs and other critical environments and/or the expected life of the equipment exceeds 20-25 years (manufacturing areas).

1.2 QUALITY ASSURANCE

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified or as denoted on the drawings and schedule.

B. Equipment furnished under this specification shall be in accordance with the following industry, association and government codes and standards, as applicable to their design, fabrication, assembly and testing.

1. AMCA 99 Standards
2. NFPA 70 National Electric Code
3. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating System
4. NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning systems

C. Fans shall be rated in accordance with the following Standards:

1. AMCA Standard 210 for performance
2. AMCA Standard 301 for sound and shall bear the AMCA seal.

D. Motors shall meet requirements of NEMA, IEEE, ANSI, and NEC standard.

E. Coils shall be rated in accordance with ARI Standard 410 and bear the ARI seal.

F. Equipment within unit shall be UL listed where applicable.

1.3 SUBMITTALS

A. QUOTATION: Provide the following detailed information on the equipment proposed. Unit manufacturer shall itemize all deviations from the specified requirements. If not so indicated, unit manufacturer will be required to furnish at no cost to the owner:

1. Information requested in the RFQ, including equipment data sheets, schedules and sketches.
2. Equipment drawings showing overall unit dimensions, and individual components and section dimensions, weights (shipping & operating), capacities, ratings, fan performance, overall configuration, major component locations, access door locations, duct connection sizes and locations, and shipping split locations.
3. Materials of construction for housing and major components.
4. Cross section details of typical wall, floor and roof construction

B. AFTER PLACEMENT OF ORDER: Make submittals in accordance with requirements of conditions of purchase. Submittals shall show Buyer's purchase order number, equipment number and project number. Information shall include, as applicable, but not be limited to the following:

1. Information submitted with quotation, revised and expanded as required; including airborne and transmitted sound power levels by octave band for unit.
2. Fan manufacturer and performance curves with the operating points clearly indicated. Motor sizes and types. Submit fan curves with specified operating point clearly plotted.
3. Detail coil selections with sizes, rows, fin spacing, face velocity, air & fluid temperatures, flow rates, air & fluid pressure drops, and connection sizes. Submit psychometric chart for each cooling coil with design points and final operating point clearly noted.
4. Shop Drawings - Piping connections, sizes and locations
5. Shop Drawings - (If applicable) Electrical data, wiring diagrams, and accessory panel layouts. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Also include point to point wiring diagrams
6. Shop drawings – construction details including methods of fastening panels, assembling sections, thermal and galvanic break techniques, and materials of construction
7. (If applicable) Factory testing procedures for review and acceptance.
8. Door and window sizes and elevations
9. Controls - Shop Drawings:

    a. System wiring diagrams with sequence of operation for each system as specified.

    b. Submit manufacturer's product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications.

C. AFTER RECEIPT OF APPROVED DRAWINGS: Submit manuals with detailed description of installation, operation, and maintenance, including the following:

1. Written recommendations for field storage, both indoors and outdoors.
2. Installation requirements including assembly instructions, lifting requirements and adjustments.
3. Manufacturer's literature describing each piece of equipment including operation instructions with step-by-step preparation of starting, shutdown, and draining and maintenance instructions including lubrication.
4. Detailed commissioning procedures.

D. PRIOR TO SHIPMENT: Submit the following detailed information prior to shipment where these tests have been requested during the bidding process:

1. Fan/Motor assembly vibration test results.
2. Air handler casing leakage test results (field tested after assembly)

3. Fan performance test result. (Determined by TAB Contractor)
4. Sound power levels at the inlet and outlet test results.
5. Panel deflection test results. (In conjunction with leakage testing).

1.4 PRODUCT CLEANING, DELIVERY, STORAGE, AND HANDLING

A. All equipment to be delivered to the job site suitably packaged and protected for overland trucking. In general, units will be delivered in one piece unless otherwise indicated. Where building constraints, unit size or trucking limitations require that unit ship in more than one piece, the manufacturer shall indicate split points on shop drawings.

B. Thoroughly clean equipment, components and subassemblies of water, dirt, debris, weld splatter, grease, oil and other foreign matter prior to shipment.

C. Unit to be prepped and completely sealed for protection during shipment.
1. Seal closures, caps and plugs dust-tight and moisture-tight.
2. Protect pipe flanges with plywood coverings; protect pipe threads with plastic end caps or plugs.
3. Protect machined surfaces with suitable, easily removable rust preventive.
4. Provide full charge of proper lubricant for grease lubricated bearings.
5. Provide desiccant bags or vapor phase inhibitors where required to keep components dry.

D. Ship all air handlers with complete protection from rain and dirt. Air handlers shipped on open trailers shall be protected with a minimum of two (2) layers of heavy mill shrink wrap plastic.

E. Units delivered with scratched, dented, or dirty surfaces or damage of any type shall be restored to “as new” condition as directed by the Engineer/Owner at no cost to Owner.

F. If equipment is to be stored before use, shipping protection provided by the unit manufacturer shall remain on the unit until the unit is installed. Manufacturer shall submit written recommendations for field storage.

G. Provide non-corrosive nameplate permanently attached to the equipment containing the following information:

1. Manufacturer’s project/serial number
2. Plant name and location
3. Customer equipment number
4. Date of manufacture

H. Provide lock down equipment for all vibration isolation during transport and handling.

1.5 WARRANTY

A. All equipment, materials, and workmanship shall be warranted for (18) months from shipment. During the warranty period, the manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material, or workmanship in which defects may develop.

B. Warranty is for parts only; labor to remove or reinstall parts is the responsibility of others.

C. Unit casing, structural base and roof shall be warranted against corrosion or failure under normal operating conditions for a period of forty (40) years from the date of unit delivery.

PART 2 UNIT CONSTRUCTION

2.1 MANUFACTURERS

A. Provide air handling units as manufactured by:

1. Air Enterprises
2. Ingenia (Basis of Design)
3. Miller Picking.

B. Alternate pricing based on pre-approved manufacturers will be considered if the following performance requirements and construction techniques are adhered to in all respects. Any substitutions shall be approved by the Engineer/Owner in writing ten (30) days prior to bid.

C. The unit manufacturer shall have been manufacturing custom built-up air handling units for a minimum of 5 years and provide references if requested.

2.2 CUSTOM AIR HANDLING UNITS GENERAL

A. Custom built units shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.

B. Classification as designated by the unit manufacturer or minimum requirement selected below:

1. Total Static Pressure		Class
a.	Up to 3.75 inches WC	I
b.	Up to 6.75 inches WC	II
c.	Up to 12.75 inches WC	III

C. The units shall be constructed for outdoor installation on structural steel dunnage. Outdoor units to be provided with weatherproofing (roofing, guttering, etc.) as defined herein. All outdoor units shall be stainless steel exterior or powder coated aluminum. Powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @400 deg F; Electrostatic paint application (powder format); Baked finish @ 400 deg F. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece retains its charge, which holds the powder to the work piece. The coated work piece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOS's), hazardous air pollutants and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and

concealed surfaces. The coating shall resist 1000 hours to the standard ASTM-B117 scratch salt spray test and resist 10,000 hours to the standard ASTM-B117 exposure salt spray test.

D. The units shall consist of: intake sections for return and outside air, mixing section with dampers for outside air, return air, pre-filter section, final filter section, heating coil sections, cooling coil section, humidifier (high pressure water atomizing) section, supply fan section and discharge section.

E. Units shall be provided with a complete LED lighting system with switches and receptacles in weatherproof enclosures. Junction boxes and distribution panels shall be NEMA 4X. Damper operators furnished and installed on all dampers by the ATC contractor. Motor wiring to NEMA 4X safety disconnect switches by unit manufacturer. LED fixtures shall be equivalent to RAB Lighting SHARK4-50W/D10. Provide outdoor LED fixtures at vestibule entrances equivalent to RAB Lighting WP-LED40 with cutoff visor. Outdoor LED fixtures to be controlled by photocell.

F. As a general rule, the unit shall employ aluminum or stainless-steel materials (panels, bases, supports and safing) to maximize cleanliness of the conditioned air, facilitate and simplify maintenance and ensure longevity of the unit by eliminating rust potential.

G. Provide safing between internal components and unit casing to prevent air bypass. Safing material shall match unit interior. All seams or voids between safing, components and unit casing shall be caulked and sealed airtight.

H. Provide hygienic unit design with interior suitable for washing down without any vapor or water transfer into the wall or base cavities. Unit insulation must be closed cell foam. This requirement is due to the incidence of mold growth with fiberglass or open cell foam insulation when it gets wet.

I. The unit is to be shipped factory assembled in one complete section, when possible. If necessary to ship the unit in sections, due to rigging or shipping constraints, the unit is to be designed to minimize the number of sections. The unit manufacturer shall Provide field erection supervision for joining of unit module sections.

J. The custom unit must fit and accommodate all constraints and still enable access to all components for maintenance and cleaning.

2.3 UNIT BASE

A. The unit shall be constructed on an all-aluminum or 304 stainless steel structural base for outdoor applications. The base shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning.

B. The base floor shall be minimum 8-gauge aluminum or 304 stainless steel plate. Floors shall be guaranteed air and water tight. Floor material shall have safety-tread surface in areas where people will be walking. The base floor shall be designed for a minimum live load of 150 pounds per square foot throughout the unit. The base floor is to be supported with adequate stiffening members to prevent oil canning. Caulking or gaskets to guarantee seals and water tightness of joints will not be acceptable.

C. The perimeter support members shall be properly sized to support all major components and the housing during rigging, handling and operation of the unit.

D. The underneath side of the base pan and base perimeter shall be insulated with injected or sprayed closed cell foam of proper R-Value to prevent any condensation beneath the unit. Fiberglass batt insulation is not acceptable. Supplier shall demonstrate through thermal modeling or actual testing that no condensation will occur at the specified ambient temperatures and humidity where the AHU will be located.

E. Each section of the unit base shall contain a minimum 1-1/2-inch NPT drain to facilitate system wash down, maintenance and/or condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Clean out drains shall be provided with removable caps of non-corrosive material. Provide a 2-inch high lip at floor to wall joint, to provide a waterproof floor capable of holding 2 inches of water without leaking. Any drain pipes in the Unit Base needs to be pitched a minimum of 1/4 inch per foot. All unit drain piping shall be schedule 40 stainless steel.

F. All equipment within air handling unit shall be provided with a minimum 1-1/2-inch-high base to raise equipment off unit floor for housekeeping. Equipment mounted directly on unit floor is unacceptable.

G. Supply air openings to be framed with 2-inch-high water dam continuously welded, or mechanically joined to the pan to allow proper duct connections and to prevent moisture from entering the openings. Framed openings shall be provided with removable aluminum or 304 stainless steel grating designed and fabricated for a live load of 100 pounds per square foot. Galvanized or painted steel grating will not be accepted.

H. All unit base service openings shall be framed with a minimum 2-inch-high water dam continuously welded, or mechanically joined to the floor. All pipe and electric conduit chases with openings to building or elements shall be covered with thin gage aluminum or 304 stainless steel. Penetrations by contractors should be minimized. If required, they shall be sealed by the respective contractor.

I. Fastening to floor plate or joining of unit sections to be accomplished by bolting through gasketed joints above the floor line, butyl rubber membrane with pressure plates, or continuously welding.

J. Unit to be provided with properly located removable lifting lugs for each section to adequately allow rigging of the unit sections in place.

K. Unit Base will be provided with mounting holes to secure it to the floor or structural steel to prevent movement created by seismic conditions. Base plates and bolt patterns shall be provided in such a manner that the forces are evenly distributed over the base of the unit.

2.4 CABINET

A. The unit casing construction is one of the most critical factors for a long-life trouble fee air handler. Construction details vary among manufacturers of custom units. This section documents the performance of the unit casing with a few specifications that prevent problems encountered in the past.

B. Complete no metal through construction (thermal break) in all locations. This no metal through construction intent is to prevent condensation and subsequent mold growth from occurring. The thermal break usually consists of a minimum ½ inch structural non-metallic bridge. Adhesive tapes or gaskets do not constitute an acceptable thermal break.

C. Unit Casing shall be built up from the unit base with load bearing panels. Panels should be capable of forming the enclosure without additional structural members. Structural members are acceptable in some instances. Panels shall be joined together with independent joining member and fastened with closed end stainless steel fasteners. Plated fasteners will not be accepted.

D. Each panel shall contain an integral frame or be properly supported by a structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation. The intent is to guarantee structural integrity and no moisture getting inside the panel.

E. The panel thickness should be dictated by the R-value required to prevent any exterior condensation, and meet the structural stiffness and noise specification. All insulation to be closed cell injected foam. At a minimum, outdoor units should have R-value of 19. Noise and stiffness requirements along with Federal energy code may dictate thicker walls with higher R-values. Under normal operating design conditions, there shall be no condensation on the unit exterior at an ambient condition of115°F DB, 80 °WB

F. Thickness of the panel skin, core density, rib structural frame spacing shall be regulated to eliminate panel pulsation and restrict the maximum deflection to L/250 of any span at design load of 1-1/2 times the design positive or negative pressure plus snow and wind loading. The maximum deflection of roof and floor shall be L/360 at design loading. Deflection is worst case at the center of the panel

G. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. Leakage to be guaranteed at no more than (0.5%) of the design volume at 1-1/2 times the design operating pressure or 50 CFM, whichever is greater. Sections of casing need to be pressure tested in pressure mode (negative or positive) which they will normally operate. For example, the suction side of the fan should be pressure tested with negative pressure differential. The units shall be field tested after assembly.

H. All casing walls shall be of panel construction, including but not limited to the fan discharge walls, mixing section walls and divider wall to the access corridor.

I. Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable. Air handlers shall have no through metal constriction.

J. Pipe and conduit penetrations through the unit casings shall be provided by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations sealed by simply caulking around extension are not acceptable.

K. Provide minimum 24 inches wide access doors for access to all internal components. Access doors shall be installed to open against the greatest pressure relative to air pressure on each side of access door. Where this is not feasible, an interlocking mechanism is required to prevent damage or injury'

1. Access doors shall be of the same construction as panels described above. This includes the thermal break requirements.
2. The door seals shall be made of a 2-component formed-in-place foam gasket (FIPFG) material. The application process shall be by means of a liquid polyurethane high pressure injection, providing a continuous seamless gasket. The non-powder coated gasket base

surfaces shall be prepped with an ethanol-based primer prior to application of the liquid polyurethane. Powder coated surfaces do not require a base primer.

3. Each access door shall contain a thermo pane safety glass window (min. 10 inches square).
4. If fan blades are exposed during operation an OSHA approved interlock switch is required on the door which de-energizes the fan before entry. Provide door interlock switch(s) to disable UV lighting system. Fan guarding is also acceptable.
5. Provide 1-inch dia. test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement.
6. Each access door shall be mounted with cast aluminum hinges and shall have a least two (2) non-corrosive handles operable from either side. Handles need to be at an acceptable height when standing outside the unit. Exterior AHUs shall utilize non-corrosive door hardware for doors subjected to an outdoor environment.

L. Removable access panels shall be provided as appropriate for service and maintenance. They need to be sized appropriately for the component that is being replaced or repaired. Access panels shall be of the same construction as panels described above. Removable access panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels. Airtight integrity must be maintained.

M. For large internal components such as fans and motors, install structural I-beam so hoist mechanism can be used to safely lift and remove the component from the unit casing.

N. Materials

1. Exterior – Outside Units powder coated Stainless Steel or powder coated aluminum exterior panels.

2. Interior - Aluminum or stainless steel with factory applied anti-microbial coating on interior panels. Polished 304 stainless steel interior panels can be utilized in lieu of the antimicrobial finish.

2.5 EXTERIOR & INTERIOR FINISH

A. The interior surfaces of the air handler shall be powder coated anti-microbial coating. Interior surfaces can be 304 polished stainless steel.

B. The Interior finish shall be WHITE ANTI-MICROBIAL powder coated or polished 304 stainless steel.

C. The powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @ 400 deg F; Electrostatic paint application (powder format); Baked finish @ 400 deg F.

D. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece retains its charge, which holds the powder to the work piece. The coated work piece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of

volatile organic compounds (VOC's), hazardous air pollutants (HAP's) and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 1000 hours to the standard ASTM-B117 scratch salt spray test and resist 10,000hours to the standard ASTM-B117 exposure salt spray test.

2.6 ROOF SYSTEM

A. Unit roofs for outdoor units are to be sloped a minimum of 1/4 inch per foot to assure positive run-off. Roof to peak in center and drain off to both sides / on door side and drain away from door side.

B. The roof system shall be constructed of powder coated 304 stainless steel. The roof panels shall be interlocked standing seam construction or a cladding roof system. The use of a membrane roofing system is prohibited. No fasteners shall be vertically installed in roofing system.

2.7 OUTSIDE AIR SECTION

A. Weather hood exterior to match the finish of the unit casing

B. Bird screen: stainless steel mesh.

C. Outside air intake shall be sized to minimize snow intake.

2.8 MIXING SECTION

A. Complete with framed openings with low-leakage outside and return air dampers. Dampers shall be as specified below and shall be furnished and installed by the unit manufacturer.

B. Mixing section shall be designed for controlled mixing in that the proximity, relation, and air velocity for each respective damper shall be such that volume swings and stratification will be eliminated.

C. Outside air damper banks can be handled in one of two ways. First, incorporate a two-position minimum outside air damper and a second independent modulating outside air damper. Second option, use of one OA damper. Minimum outside air provided by controlling outside air damper bank to a minimum position. Outside air should have flow station as a means of demonstrating compliance for outside air intake. Outside air damper and flow station shall be equal to Tamco/Ebtron series 2900 AIR-IQ2.

D. Mixing should eliminate possibility of air stratification where cold outside air can freeze chilled water coil or an air blender needs to be incorporated into the design.

2.9 FILTER SECTIONS

A. Provide all pre-filters and final filters of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications. Filters to be selected for a maximum face velocity of 500 fpm.

B. Filters shall have nominal rating of 500 fpm. Each cell shall be 24 inches x 24 inches, or 12 inches x 24 inches. Media shall be approved and listed as Underwriters Laboratories Class 2 when tested according to UL Standard 900 and as described below:

1. Pre-filters: 2-inch thick MERV 8 efficiency, equal to AAF PerfectPleat HC M8.
2. Final Filters: 12-inch rigid pleated V-type, MERV 14, equal to AAF VariCel RF
3. HEPA Filters: 99.99% (when tested with 0.3 micron thermally generated particulates) high-volume HEPA filters tested and certified, equal to AAF SuperFlow 24.

C. Filters shall be upstream removable (face mounted). Side access is not acceptable. Pre-filter sections shall be complete with holding frames capable of holding pre-filters with high efficiency filters. Pre-filters shall be capable of being removed and installed without affecting seal of the high efficiency filter.

D. Filter frames shall be aluminum construction. Filter frame gaskets shall be made of a 2-component formed-in-place foam gasket (FIPFG) material. The application process shall be by means of a liquid polyurethane high pressure injection, providing a continuous seamless gasket. The non-powder coated gasket base surfaces shall be prepped with an ethanol-based primer prior to application of the liquid polyurethane. Powder coated surfaces do not require a base primer. No gaskets needed on filter frames where filters are purchased with gaskets (HEPA filters ONLY). Filter holding frames shall be installed and individually sealed to prevent leakage around frames. Filter banks shall be reinforced with vertical stiffeners to assure rigidity for up to 3.5-4 inches pressure differential. Unit manufacturer shall provide flashing between filter banks and unit casings to prevent air leakage or bypass around the frames. Installation techniques, sealing methods, and structural reinforcement eliminate unfiltered air bypass and assure system cleanliness based on filter efficiencies specified.

E. Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with copper static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank. Provide hose barbs to connect indicating transmitter to the control system.

F. Unit manufacturer shall provide (2) sets of pre-filter media and (2) sets of final filter media, and (1) set of HEPA filter media.

G. Acceptable filter frame manufacturers are as follows:

1. Pre-filter and Final-Filter

   a. Camfil – Type 8

   b. Ingenia
   c.

2. HEPA filter

   a. Camfil – Magnaframe

   b. Ingenia

2.10 HEPA FILTERS

A. The final filters shall be HEPA high-volume type. Only approved HEPA framing system shall be used. Air filters shall be HEPA grade high-volume air Filters (24 x 24 rated for 2400 CFM at 1.0 inch w.g.) with waterproof micro glass fiber media, , urethane sealant, anodized extruded aluminum frame, and neoprene sealing gasket. Filter media shall be one continuous pleating of micro glass fiber media mini-pleated. Overall dimensional tolerance shall be correct within -1/8 inch, +0 inches, and square within 1/8 inch. A poured-in-place seamless sealing gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.

B. The filter shall have a tested efficiency of 99.99% when evaluated under the guidance of IEST TEST A Recommended Practice RP-CC001. The Initial resistance to airflow shall not exceed 1.0 inches w.g. at rated capacity. Filter shall be rated by Underwriters Laboratories as. The filter shall be capable of withstanding 10 inches w.g. without failure of the media pack. The filter shall be labeled as to tested efficiency, rated/tested airflow, pressure drop and shall be serialized for identification.

2.11 COIL SECTIONS

A. HEATING COIL

1. Each coil shall have been hydrostatically tested up to 150 psig for temperatures ≤200F and five times the operating pressure for temperatures >200F and shall be designed for continuous operation at 200 psig and 220 deg. F.
2. Water coils shall have copper headers and red brass threaded connections. Drain and vent connections shall be incorporated into the header and extended to the exterior of the casing.
3. The coil frame material shall be 304 stainless steel.
4. The tubes shall be copper with a nominal diameter of 5/8 inch and 0.035-inch-thick wall.
5. Heat transfer fins shall be aluminum and shall have a nominal thickness of 0.010''.
6. Reheat coils shall be provided as scheduled and all supply, return and vent piping shall be terminated in the service vestibule. Extended piping for far side coils by contractor.
7. Preheat coils shall be provided as scheduled and all supply, return and vent piping shall be terminated in the service vestibule. Extended piping for far side coils by contractor.
8. Provide coil racks that allow for individual coil removal without disturbing other coils. Racks to be constructed of 304 stainless steel.

B. COOLING COIL

1. Water coils shall have copper headers and red brass threaded connections. Drain and vent connections shall be incorporated into the header and extended to the exterior of the casing.
2. The coil frame material shall be stainless steel.
3. The tubes shall be copper with a nominal diameter of 5/8 inch and 0.035-inch-thick wall.
4. Heat transfer fins shall be aluminum and shall have a nominal thickness of 0.010''.
5. Where noted the cooling coil section shall be arranged in a face and bypass arrangement. The coil shall have a face damper while the space above the coil shall have a bypass damper that fills the available space. Dampers shall be equal to TAMCO series 1000 and actuators shall be provided and installed by the ATC contractor.
6. Space shall be allotted between the cooling coil section access door and the door serving the fan inlet plenum for future installation of air blenders.
7. Provide coil racks that allow for individual coil removal without disturbing other coils. Racks to be constructed of 304 stainless steel.

8. Coil racks to include 304 stainless steel intermediate drain pans for stacked coils.

2.12 SUPPLY FAN SECTIONS

A. General Guidelines are as follows:

1. Provide fans, motors and drives of number, size and capacity as required and appropriate for the application. Design should incorporate the optimal number of fans to maximize efficiency and meet the agreed upon redundancy specification. Selecting the least number of fans that meet the redundancy requirements will normally produce the most efficient system design.
2. Reference Standard 23 34 16 – Fans for general info on construction and performance.
3. System effects must be carefully evaluated to ensure no excessive efficiency losses.
4. Direct drive fans are preferred in most instances to eliminate mechanical belt losses and maintenance required by units which have belts and sheaves.
5. All motors shall include isolated bearings or shaft grounding to prevent premature bearing failure due to VFD induced electrical damage.
6. Performance: Performance ratings shall conform to AMCA standard 205 (fan efficiency grade), 211 (air performance) and 311 (sound performance). Fans shall be tested in accordance with ANSI/AMCA Standard 210 (air performance) and 300 (sound performance) in an AMCA accredited laboratory. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air and fan efficiency grade (FEG).

B. FAN ARRAY SYSTEM

1. The Fan Array system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements, class as specified on the schedule.
2. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans shall have a non-overloading design with self-limiting horsepower characteristics and shall reach a peak in the normal selection area. All fans shall be capable of operating over the minimum pressure class limits as specified in AMCA's Standard 2408-69.
3. PERFORMANCE - Fans shall be tested in accordance with AMCA 211 and AMCA 311 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air.
4. Performance data on fans with shaft, bearings, and bearings bar in the inlet shall be de-rated to account for inlet restrictions and shall be licensed to bear the AMCA certified ratings seal for both sound and air.
5. CONSTRUCTION – Fans shall be designed without a scroll type housing and shall incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge reinforced steel inlet plate, structural steel frame, and shaft and bearings.
6. FRAME AND INLET PLATE – Inlet plates shall be of heavy-gauge reinforced steel construction. The inlet plate incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel. A square, formed lip suitable for attachment of a boot connector shall surround the unit, or an optional round inlet collar can be provided.
7. WHEEL – Wheels shall have a spun non-tapered style blade, retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. Sizes 245 and smaller shall have airfoil-shaped extruded aluminum blades. Sizes 270 and larger shall

have die-formed airfoil steel blades with the option of extruded aluminum blades. All wheels on direct drive arrangement 4 fans shall have airfoil-shaped extruded aluminum blades. All hollow blade wheels shall be continuously welded around all edges. Wheels shall have nine blades for high efficiencies. All wheels shall be statically and dynamically balanced on precision electronic balancers to a level of G6.3 (per ANSI 2019) or better.

8. FINISH AND COATING – The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust-preventive primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum-based rust protectant. Aluminum components shall be unpainted.
9. FAN MANUFACTURER FACTORY RUN TEST - All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained, and a written copy shall be available upon request.
10. . Each fan/motor cartridge shall be rigidly mounted on 1-inch deflection vibration isolators and balanced as an assembly to 0.12 inches / second filter in.
11. For all fan arrays, maximum individual motor size is 25 HP.
12. Fan wheels shall be aluminum airfoil type with minimum 9 blades, and fully welded.
13. The fan array shall be provided with acoustical liners that reduce the bare fan discharge sound power levels as scheduled. The silencers shall not increase the fan total static pressure, nor shall they increase the airway tunnel length of the Air Handling Unit when compared to the same fan array unit without the silencer array.
14. Manufacturers must submit acoustical data for review and approval prior to the bid indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP for each fan array. Proposals submitted which indicate a higher connected fan HP than specified or scheduled will not be accepted.
15. The fan array shall consist of multiple fan and motor "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
16. The Fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12 inches from the intake side of the Fan array intake plenum wall, and at a distance of 48 inches from the discharge side of the Fan plenum wall.
17. Each fan/motor "cell" will be provided with an individual back-draft damper. Backdraft dampers shall be extruded aluminum on frames and blades and engineered to produce minimum static pressure loss at the designed operating conditions. Seals shall be solid rubber. Bearings shall be rubber shielded radial ball bearings, permanently lubricated.
18. Provide a sliding motor removal rail in all fan sections.
19. Each fan motor shall be wired to a factory mounted and wired NEMA 4X disconnect switch. An owner supplied VFD shall be shipped to the AHU manufacturer for installation and wiring within the service vestibule.
20. Acceptable fan manufacturers:

    a. Twin City Fan (preferred)
    b. Greenheck
    c. New York Blower

C. MOTORS: shall be 1750 RPM, 460V/3ph/60Hz as per the following:

1. Motor shall be true synchronous speed, switched reluctance type, IE4+ efficient, totally enclosed fan cooled (TEFC) rated for severe duty or higher.
2. Motor shall be of HP as listed on schedule and be selected for a minimum of 15-20% over calculated BHP. The motor service factor shall be a minimum of 1.0and an efficiency IE3 when operating on a VFD. Motor shall be of HP listed on schedule; selected to provide adequate torque throughout entire range of fan operation and not exceed nameplate HP when fan operates at synchronous motor speed.
3. Motor shall be designed for continuous duty operation, NEMA Design B with class H insulation.
4. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.
5. Motors shall be “Inverter Duty Rated” per NEMA Std. MG1 part 31.4.4.2 and labeled as such.
6. Variable frequency PWM driven motors shall include a circumferential, conductive micro fiber shaft grounding ring or equivalent shall be installed on the AC motor to discharge shaft currents to ground.
7. Provide stainless steel nameplate indicating the following:

    a. NEMA efficiency index nominal efficient (MB1-12.53BO).
    b. AFBMA bearing numbers.
    c. Lubrication instructions.

8. Acceptable motor manufactures:

    a. Baldor, RPM XE eXtreme Efficient Motors.

    b. No substitutions.

9. The use of EC motors is prohibited.

D. FAN MOTOR LIFTING AND HANDLING RAILS

1. Fan/motor sections with motors shall include lifting rails to facilitate the lifting and handling of the motor to the exterior of the AHU cabinet.
2. The rails shall include an extendible mechanism to ensure that the motors can be handled to the exterior of the AHU cabinet.
3. By means of columns and beams, the system load must be transfer to the AHU floor framing system.
4. Lift trolley shall be included with the unit, by the unit manufacturer.

2.13 CONTROL DAMPERS

A. Dampers shall be low leakage type with flexible seals for frame and blades.

B. Dampers shall be sized appropriately without blanking off free areas

C. Damper capable of withstanding 5.0” WC differential pressure.

D. Damper should be maintenance free, other than yearly wipe down. Damper should have concealed linkages. No lubrication should be needed for bearings or linkages. Bearings are composed of a Celcon inner bearing - fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin - rotating within a polycarbonate outer bearing inserted in the frame. This eliminates action between metal-to-metal or metal-to-plastic riding surfaces.

E. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures.

F. Outside air damper banks can be handled in one of two ways. First, incorporate a two-position minimum outside air and an independent modulating outside air damper. Second, minimum outside air provided by controlling outside air damper bank to a minimum position. Outside air should have flow station as a means of demonstrating code compliance for outside air.

G. Damper actuators to be provided and mounted by (ATC Contractor). Actuators for dampers with modulating control to be provided with position feedback (4-20 ma).

H. Damper should be appropriate for the application. Outside air damper should be designed to prevent freeze-up and reduce condensation. Maintenance free oiled bronze bearings preferred.

I. Acceptable dampers: Low Leakage TAMCO Series 1000 or Ruskin model appropriate for the application. OA dampers shall be equal to TAMCO 9000 series, thermally insulated type. Where OA airflow measurement is required provide TAMCO/EBTRON Series 2900 AIR-IQ2 damper with integral airflow measurement.

2.14 DRAIN PANS

A. Condensate drain pan are Indoor Air Quality compliant complying with ASHRAE Standard 62.1-2007 Ventilation for Acceptable Indoor Air Quality.

B. Fabricated from minimum thickness 16-gauge 304 stainless steel

C. Absolutely no standing water allowed to accumulate in the pan.

D. Minimum 1 1/2-inch drain connection at lowest point in the pan.

E. Coils to be mounted on supports above drain pan. Coil supports cannot prevent water drainage.

F. Air cannot bypass around coil through drain pan.

2.15 AIR FLOW MEASUREMENT

A. Provide airflow measurement device and transmitters for the purpose of continuously monitoring unit airflow volume. This includes outside air flow and total air flow as required and building codes.

B. Fan inlet flow measurements shall be accomplished with the Accutrol Vortek VTFA. The VTFA uses 24V (AC or DC) input power and the device will output airflow via analog output signal or optional BACnet. Analog output offers the total flow of the fan array while BACnet offers individual fan airflow to be summed by the ATC.

C. Acceptable manufacturers:

1. Ebtron or Vortek VTFA by Accutrol. Provide Ebtron Gold series or Accutrol VTD for duct mount AFMS.

2.16 ULTRAVIOLET LIGHTS

A. Independent Testing – All UV-C fixtures shall have been tested and labeled as UL Listed.

B. Fixtures – Fixtures shall be HVACR style high output (HO) types optimized for both heating and cooling temperatures of from 1-70□ C, in air streams of 750 fpm. Fixtures shall be constructed of hospital grade (304) stainless steel and shall be capable of being mounted anywhere in the system and/or as shown on the plans. Each fixture shall be constructed with mounting holes, weep holes, and 6- ½" electrical knockouts, 3- at each end, to facilitate installation.

C. Power Supplies - Power supplies shall be completely waterproof and be of the high efficiency electronic type, matched to the lamp and designed to maximize UV-C photon production, lamp irradiance, energy efficiency and reliability. They shall be waterproof and UL Listed and labeled for use in air-streams of 1-70° C. They shall be capable of producing the specified output and organism destruction as specified under Intensity using no more than 10 Watts of power consumption for each square foot of treated, cross-sectional plane.

D. Lamps – Lamp Watts shall be printed clearly on all lamps. Lamps shall be high output (HO), T5 diameter, rapid-start, medium bi-pin types that produce UV-C of 254 nm. Each lamp shall contain no more than 8 mg of mercury and shall be capable of operating in air temperatures of 1-70□ C and velocities to 750 fpm. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of lamp life when used continuously. They shall be constructed with UV-C resistant bases and shall not produce measurable ozone.

E. Irradiation - Lamps and fixtures are to be installed in sufficient quantity and in such a manner so as to provide an "equal" distribution of UV-C energy within the irradiated plenum. When installed, the UV-C energy shall be of the lowest possible reflected and shadowed losses.

F. Intensity - The minimal UV-C energy striking all surfaces shall at all times be sufficient to continuously destroy surface mold and bacteria as typically found in HVAC systems.

G. Installation – When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the fixture row lengths shall be equal to a minimum of 90% of the coil surfaces width. Fixture rows shall be electrically terminated in accordance with both NEC and local codes. Fixtures shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection.

H. Safety – UV-C system On/Off switches shall be installed on the exterior of all UV-C plenums next to the plenum access door. Mechanical interlock switches shall be installed on all access panels and doors to the UV-C plenums to ensure that the UVC fixtures will be de-energized when any of these accesses are opened.

I. Provide status and alarm contacts to air handler control system.

J. Acceptable manufacturers:

1. Steril-Aire
2. UV Resources
3. FRESH-AIRE UV.

2.17 EVAPORATIVE HUMIDIFICATION SYSTEM

MATERIALS AND COMPONENTS: Where specified, provide packaged humidifiers and ancillary equipment with manufacturer's standard materials and components as indicated and published product information, designed and constructed by manufacturer, and as required for complete installation.

2.18 HIGH PRESSURE WATER ATOMIZATION TYPE HUMIDIFIER

A. General: Provide high pressure water atomization type humidifier including the following components:

1. Fog nozzles.
2. Fog pump unit(s)
3. Water treatment equipment (using RO treated water).
4. Fog nozzle manifolds and main feed lines.
5. Droplet Filters and frames
6. Electrical panels and automatic control valves.

B. The system component sizes and capacities shall meet the specified load for humidification zones.

C. High pressure humidification system shall not use more than .003 kW/# of moisture generated.

D. Fog Nozzle Section:

1. Nozzle: 316 stainless steel construction with a 0.008-inch machined orifice.
2. Median droplet size to be between 10-40 microns with 95% of the droplets at 15 microns or less at 1,000 psig operating pressure.
3. The nozzle manifold to be constructed of 1/2-inch OD 316 stainless steel tubing with 0.035-inch wall thickness.
4. Nozzle saddles to be TIG welded to the manifold.
5. All connections between tubing to be 316 stainless steel double-ferrule compression fittings.
6. Nozzle section in AHU must be non-corrosive and include a stainless-steel drain pan that slopes to the drain.

E. High pressure water pump units:

1. Complete fog pump units shall include the following:

a. Oil lubricated ceramic plunger pumps with stainless steel heads: Water lubricated axial piston pumps are not to be used due to noise and vibration.
b. Direct drive connection to the motor. Belt driven not to be used.
c. Frame: Components to be mounted on a 304 stainless steel frame.

d. Allen Bradley PowerFlex 755 VFD with pressure transducer to maintain pump pressure.
e. Pump system shall be rack mounted and fully assembled at the factory. The factory mounted equipment includes pumps, VFD's, filters, and associated control panels. Rack to be fully tested at the factory prior to shipment. Pump System PLC Shall be Allen Bradley Compact Logix 5370 series controller.
f. Pressure regulating valves: Stainless steel construction with stainless steel valve and valve seat.
g. Electric motors shall be TEFC, Inverter duty premium efficiency model.
h. Pump unit shall be capable of operating minimum zone without overheating of pump.
i. Low water pressure cut-off: To protect pump in the event of low inlet pressure, manual reset with signal to BMS.
j. Low pressure discharge switch. To shut down the system if the pressure is not able to maintain 1,000 psi. Manual reset with signal to BMS.
k. Pump bypass to RO storage tank or finned tube heat exchanger for pump cooling during part load.
l. Low pressure gauge: liquid filled, for 0 to 100 psig.
m. High pressure gauge: liquid filled, for 0 to 2,000 psi.
n. Fitting and hoses: low-pressure side fittings shall be stainless steel construction. High-pressure side fittings shall be of 304 stainless steel. Low-pressure inlet hoses and high-pressure discharge hoses shall be provided as part of humidification system.
o. All wetted parts including piping shall be non-corrosive (stainless steel). Provide all necessary dielectric isolation.

2. Acceptable manufactures:

a. Go Fog
b. American Moistening Company (AMCO)
c. Dri-Steem.

2.19 WATER TREATMENT

A. Reverse osmosis (RO) water treatment system will be provided by owner. The RO treated water shall be piped to the fog pump units for this central humidification system as part of this humidification work. Building water to be 50-74 F at the inlet of the water treatment system. The RO system shall be controlled by an Allen Bradley ControlLogix 5580 controller. Control system for integration into the BMS system. Provide 10-inch touchscreen interface to allow for status, set point control and alarm monitoring. Provide polyethylene storage tank. Provide guided wave radar continuous level probe in storage tank. Level probe shall be Keyence FL Series Liquid Level Sensor. Control system shall meet GPO standards for construction.

1. The system supplier shall conduct complete water analysis on the RO treated water and make recommendation for water treatment additionally required prior to commencing work.
2. Water treatment system shall protect against:

a. Excessive plugging of nozzles, not more than 10% per year.
b. Any water condition that could cause excessive wear or damage to the fog nozzles.
c. Any dangerous bacteria growth or any condition that could result in dangerous bacteria growth, and any possibility of "dusting" of the air with mineral salts.

d. Droplet Filters and Frames: Filters shall be UL Class I rated; polymer based with biocide agent. Filters shall be rated for use up to 700 fpm. Filters shall be installed in a stainless-steel frame.

3. Zone control valves:

a. High pressure motorized ball valves shall be provided on the water supply line to each humidification zone to stage the humidification process at the fog nozzles. The valves shall be rated for a minimum 6,000 psi operating pressure with stainless steel wetted parts.
b. Valve control panel to be wired to AHU PLC I/O .
c. Valve control panel to send a 24VDC pump enable during a demand for humidity.
d. Flush cycle to occur once every 24 hours for 30 seconds on each valve to keep fresh water in the system.
e. Humidification system supplier will provide PLC sequence of operation to controls contractor to integrate valve logic logic into AHU PLC.

2.20 OUTDOOR SERVICE VESTIBULE

A. Unit to be provided with an integral Service Vestibule. Access corridor to be minimum (8) ft. wide by full height and length of the unit. The access corridor shall be of the same construction as the unit previously described. Access corridor floor shall be level without obstructions such as at joining sections that might act as trip points.

B. Provide a 5KW 3/60/460V electric unit heater with wall mounted thermostat for maintaining a minimum of 50°F temperature during winter operation. Provide factory mounted and wired heater, disconnect switch and thermostat. Provide ventilation for removing heat of variable speed drives and other devices within the vestibule by means of manually adjustable blast gates mounted in the side wall of the mixing box and supply air plenums.

C. The service corridor shall provide for floor supporting of field piping installations. A pipe support structure shall be included as a means for pipe hangers to be attached to supporting members with no fastening done to the AHU/corridor ceiling or walls. The support members shall be three feet on center and sized to support a uniform piping load of 250 lbs./ft. Pipe supports are to be provided by the AHU manufacturer and locations coordinated with the installing contractor.

2.21 ELECTRICAL

A. Switches: Hubbell Model HBL 1221W, CSA certified, 20 amps, 120-volt AC. Single pole Switch, , self-grounding, side wire termination. Unless otherwise shown or specified, connect all air handling unit lighting fixtures to one switch. Junction box shall be “THOMAS & BETTS” universal FSU – 2 3/8 inches deep, cast aluminum and supplied with close-up plugs. Cover plate shall be plunger type with weatherproof enclosure..

B. GFCI Receptacles: Hubbell GF20WL, duplex, CSA certified, heavy duty, white, 20 Amps, 125-volt AC. Two poles, 3 wires, flashing red LED signals loss of GFCI protection, steady on red LED signals ground fault condition. Back and side wire terminations accept up to #10 AWG wire. Provide (2) GFCI receptacles within service vestibule.

C. 120-volt mini load centers: Square D “QO” NEMA 3R, 125A rating, part #QO124L125PGRB.

D. Factory scope of work: The unit manufacturer shall furnish and wire a complete electrical system for the 120-volt load components. All 120-volt components shall be wired to terminate at a breaker panel / load center. Each circuit shall not exceed 20 amps. Provide multi-circuit breaker panels as required. Each air handling unit shall require a 480-volt single point power connection. Single point power connection panel is to be mounted in the service vestibule within line of sight of the motor and shall include means of disconnect. Wiring between the motor and VFD, and the VFD and single point power connection panel is to be done in the factory. Wiring between the motor and the VFD shall be XHHW-2 or RWU90 cable.

E. Wiring and Conduit: The unit wiring shall be stranded copper wire sheathed in a THHN covering, which will be distributed through the unit in threaded rigid aluminum conduit; the use of aluminum wire or BX cable is prohibited. To allow for adjustment of fan motors, a 3'-0" section of weatherproof flex connect shall be provided at each motor. A separate ground wire for each motor shall be connected to a terminal in the disconnect switch. In addition to the requirements herein, wiring shall comply with NEC requirements for wash down duty (NEMA 4X). Inter-modular wiring shall terminate in a coiled configuration at the end of each module. The contractor shall pull the cables through the modules to complete the system wiring. Wiring conduit shall be EMT, equivalent to Columbia-MBF E-Z Pull EMT.

F. Control Conduit: Provide one (1) 1-1/4-inch conduit raceways along the entire length of each unit with 12-inch X 12-inch X 8-inch stainless steel NEMA 4X junction boxes in each compartment section, to allow for routing of automatic temperature control wiring and tubing through the unit for outdoor units.

2.22 AHU CONTROL POINTS

A. Refer to contract documents for point listing. ATC contractor to utilize P&ID drawings for I/o Points. All control components, their installation, wiring and commissioning are to be by the ATC contractor.

PART 3 - EXECUTION

3.1 AIR HANDLING UNITS

A. Mount on steel grillage as indicated.

B. Construct field joints in accordance with manufacturer's recommendations. Provide continuous gaskets and caulk to assure air and water tightness.

C. Check all seams and seals around coils and other components for leaks that may have developed in shipment and handling. Seal all leaks airtight in accordance with manufacturer's recommendations.

D. Locate as indicated. Level unit.

E. Provide electrical interconnection between unit and any remote-control panel in accordance with the electrical sections of this specification.

END OF SECTION 23 73 23