SECTION 15855 – AIR HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of air handling unit work is indicated on drawings and schedules, and by requirements of this section.

B. Refer to other Division 15 sections for vibration control units used in conjunction with air handling units; field-applied insulation to air handling units; piping required in conjunction with air handling units; not work of this section.

C. Electrical Work: Refer to Division-15 section "Electrical Provisions of Mechanical Work" for requirements.

D. Provide the following electrical work as work of this section, complying with requirements of Division-16 sections:

1. Control wiring between field-installed controls, indicating devices, and unit control panels.

a. Control wiring specified as work of Division-15 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of semi-custom packaged air handling units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.

2. ARI Compliance: Test and rate air handling units in accordance with ARI 260, 410, 430 and 1060D display certification symbol on units of certified models.

3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

4. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

5. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards.

6. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gauges and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing section by section unit dimensions, weight loadings, required clearances, construction details, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 15.

E. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 15.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air handling units with factory-installed shipping skids and lifting lugs; pack components in factory- fabricated protective containers.

B. Handle air handling units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.

C. Store air handling units in clean dry place and protect from weather and construction traffic.

D. Comply with Manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final location.

E. Air handling units shall be broken down and shipped in components as field conditions require. A factory authorized representative shall inspect the final installation to certify that the unit has been reassembled per factory recommendations and specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide air handling units of one of the following:

1. Trane
2. York
3. McQuay

2.2 OUTDOOR AIR HANDLING UNITS:

Edit Note: The following is based on Trane T-Series outdoor unit.

A. Air Handling Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. If air handling units are not certified in accordance with ARI 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

B. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-91.

C. Provide one set of disposable filters and one set belts or each air handler.

D. A parts warranty for one year from date of start-up shall be provided at no additional cost.

E. Factory fabricate air handling units of sizes, capacities, and configurations as scheduled on drawings.

F. The unit shall be able to withstand up to 1.5 times design static pressure, or 8-inch wc whichever is less, with no more than 0.005 inch deflection per inch of panel span.

G. The unit base design shall allow unit to rest on top of roofcurb when field installed. Entire length and width under base shall be sealed for weather tight seal.

1. Provide full perimeter gasket to isolate unit from curb.

H. Casing:

1. All panels shall be double wall construction. Interior and exterior panels shall be constructed of galvanized steel. Panel insulation system shall provide a minimum R value of 12. Insulation shall conform to NFPA 90 requirements.

2. Panels shall be fully removable to allow for a proper way to thoroughly clean panels and to access internal parts. If panels are not removable, then manufacturer shall provide access sections with doors between all internal components to ensure access and cleanability of the air handler.

3. Access doors shall be constructed with a double-wall of solid G90 galvanized steel interior panel. Gasketing around the full perimeter of the access door shall be used to prevent air and water leakage.

4. To facilitate inspection of internal components, provide sealed tempered glass view windows in doors accessing moving parts.

5. Perforated interior liner with fiberglass insulation shall be applied to [entire unit] [fan section only].

6. Provide marine lights in all sections. Preferred marine light shall be UL light wet location fluorescent light. Light shall be complete with bulb, ballast, and junction box.

7. External surface of unit casing shall be prepared and factory coated with a minimum 1.5 mil enamel finish or equal. Unit casing exterior with factory coating shall be able to

withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing will be provided with manufacturer's standard color.

8. Unit roof shall be sloped a minimum .25 inch per foot either from one side of unit to other or from center to sides of the unit. Roof assembly shall overhang all walls of units by 2 inch minimum.

9. For units with outside air requirements, manufacturer shall provide inlet hood with high performance moisture eliminator to prevent water carryover into unit casing room from outside air. Hoods shall be sized for 100% economizer cycle. If louvers are provided, then louvers shall be tested by an independent AMCA approved laboratory for water carryover and air pressure drop in accordance with AMCA standard 500, and testing reports shall be supplied with the submittal data.

10. Galvanized steel roof mounting curb with wood nailing strip, and neoprene gasket shall be supplied by the unit manufacturer. If unit requires external piping cabinet, a separate curb shall be supplied for support of the external cabinet.

I. Fans Sections

1. Provide supply fan section(s) with [FC] [BI] [AF] double width, double inlet centrifugal fan designed and suitable for class of service indicated in the unit schedule. Fan shaft to be properly sized and protectively coated with lubricating oil. Fan shafts shall be solid and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fans shall be statically and dynamically tested as an assembly at the required RPM to meet design specifications. Key fan wheels to fan shaft to prevent slipping.

   a. Provide self-aligning, grease lubricated pillow-block ball bearings selected for L-50 400,000 hour average life per ANSI/AFBMA 9. Extend both grease lubrication fittings to drive side of unit attached to drive side bearing support.

OR

1. Provide supply fan sections with AF single width, single inlet centrifugal plug fans designed and suitable for class of service indicated on unit schedule. Fan shaft to be properly sized and protectively coated width lubricating oil. Fan shafts shall be solid and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fans shall be statically and dynamically tested as an assembly at the required RPM to meet design specifications. Key fan wheels to fan shaft to prevent slipping.

   a. Equip centrifugal plug fans with self-aligning, grease lubricated pillow-block ball bearings selected for L-50 400,000 hour average life per ANSI/AFBMA 9. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

2. Mount fans on [inertia base] isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with 1 inch spring isolators. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A.

3. Fan sections shall have full height, double wall, hinged doors on drive side for inspection and maintenance of internal components.

4. Fan sections with plug fans shall have [door switches for fan shut-off] [galvanized expanded metal access door guards to prevent unauthorized entry into fan sections when access doors are opened]. Design access door guards for removal from outside of unit. On plug fan sections with vertical down discharge a safety grate shall cover entire down discharge opening to prevent service personnel from falling into supply air ductwork.

5. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM as scheduled on drawings.

6. For fan sections controlled by variable frequency drives, balance at speeds between 25% and 100% of design RPM.

J. Motors and Drives:

1. Factory install all motors on slide base to permit adjustment of belt tension.

2. Fan motors shall be heavy duty, [high efficiency open drip-proof] [high efficiency TEFC] [premium efficiency open drip-proof] [premium efficiency TEFC], operable at 460 volts, 60 Hz, 3-phase.

3. V-belt drive shall be [variable] [fixed] pitch rated at 1.2 times the motor nameplate.

K. Coils Section:

1. The wet section of the unit, defined as the entering air side of the dehumidification coil to the leaving edge of the drain pan, shall be insulated. The insulated shall meet UL 181 requirements. The air stream surface of the insulation shall be constructed or coated such that it is not biodegradable, repels water and it can be cleaned to prevent microbial growth. The manufacturer's maintenance instructions shall describe the proper cleaning procedure for the unit.

2. Construct coils of plate fins and seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes my means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

3. Construct coil casings of galvanized steel with formed end supports and top and bottom channels. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.

4. Coil Design:

a. 10 fins per inch maximum
b. 500 FPM maximum velocity for cooling coils
c. 700 FPM maximum velocity for heating coils
d. 6 row minimum cooling coil
e. Minimum 3 FPS water velocity for chilled water coils.
f. Minimum 1.5 FPS water velocity for constantly pumped chilled water coils.
g. Minimum 1.5 FPS water velocity for hot water coils.
h. Minimum 0.75 FPS water velocity for constantly pumped hot water coils.

5. Hydronic Coils:

a. Clearly label supply and return headers on outside of units such that direction of coil water flow is counter to direction of unit airflow.
b. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.
c. Construct headers of round copper pipe or cast iron.
d. Construct tubes of ½ inch OD minimum .016 inch thick copper and construct fins of aluminum.

6. Steam Heating Coils:

a. Clearly label supply and return connections on outside of units.
b. Provide non-freeze steam distributing type coils. Pitch steam coils in units for proper drainage of steam condensate from coils.
c. Proof test coils to 300 psig air under water and leak test coils to 200 psig air pressure under water.
d. Construct headers of cast iron or round copper pipe.
e. Construct tubes of 5/8 inch OD copper inner tubes and 1 inch OD minimum .031 inch thick copper outer tubes. Construct fins of aluminum.
f. Inner tubes shall have orifices that ensure even steam distribution across coil face. Direct orifices toward return connections to ensure steam condensate is discharged from coils.

7. Refrigerant Cooling Coils:

a. Clearly label suction and liquid connections on outside of units.
b. Proof test coils to 450 psig air under water and leak test coils to 300 psig air pressure under water. Dry insides of coils after testing and seal all connections.
c. Construct suction headers of copper tubing. Suction connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.
d. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

L. Drain Pan Construction:

1. Provide insulated drain pans constructed of G90-U galvanized steel exterior panels and G90-U galvanized steel interior liner. Encase insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with cooling coils shall have drain pans under complete cooling coil section. All drain pan connections will be to the side of the unit to enable proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-mircrobial treatment.

M. External Piping Enclosure:

1. Piping enclosure shall be supplied by the manufacturer factory assembled and shall be of the same construction as the main unit casing. Piping cabinet shall be external to the unit and be shipped separate for field installation in order to facilitate piping of the unit coil(s). Piping cabinet to cover unit sections as specified on schedule and shall have access door(s), or removable panels, as specified.

N. Filters:

1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double-wall, hinged

doors for filter removal. Filter sections shall flange to other unit components. Provide filter blockoffs as required to prevent air bypass around filters.

2. Provide 2 inch Merv 8 flat filter sections with throwaway filters. Filters shall be removable from one side(s) of filter sections.

3. Provide high efficiency final filter sections with 12” cartridge filters and 2” throwaway media 30% pre-filters in order to provide proper filtration. High efficiency filters shall be Merv 14 and rated in accordance with ASHRAE 52 and UL class 1 or class 2. Filters shall be removable from one side of filter sections.

O. Dampers:

1. Provide internally mounted ultra low leak outside air dampers. Dampers shall be Ruskin CD60 double skin airfoil design or equivalent. Construct damper blades and damper frames of galvanized steel. Provide parallel blade action with metal compressible jamb seals and extruded vinyl blade edge seals. Blades shall rotate on stainless steel sleeve bearings. Damper blade lengths shall not exceed 60 inches. Leakage rate shall not exceed 5 CFM/square foot at one inch water gage and 9 CFM/square foot at 4 inches water gage. All leakage testing and pressure ratings will be based on AMCA Publication 500.

OR

Provide dampers to modulate the volume of return air. Damper blades shall be galvanized steel, housed in an axle rod rotating on bearings. Blade seals are required to assure tight closure. All dampers shall be rated for a maximum leakage rate of less than 1 percent of nominal CFM at one-inch w.g.

2. Provide a factory-mounted damper/airflow monitoring station in the outdoor air damper opening of the mixing box. Damper blades shall be galvanized steel, housed in a galvanized steel frame and mechanically fastened to an axle rod rotating on bearings. The dampers shall be rated for a maximum leakage rate of less than 1 percent of nominal CFM (L/s) at 1 in. wg (249 PA). The airflow measurement station shall measure up to 100 percent of airflow. The airflow monitoring station shall output a 2-10 VDC signal representing velocity and shall have a total accuracy of (+/-) 5 percent of actual flow down to 15 percent of nominal flow between
-40 F (-40.0 C) and +158 F (70.0C). Airflow monitoring stations that require a change in duct arrangements from the current design will not be acceptable.

OR

Provide solid state electronic air measurement system (EAMS) as specified on schedule and drawings. Contractor is responsible for mounting EAMS in strict accordance with manufacturer’s recommendations. EAMS station shall be capable of functioning accurately between -20 degrees F and +158 degrees F and have the ability to transmit a 2-10 VDC linear signal representative of velocity. The measurement system shall be factory calibrated with a total accuracy of +/- 5% of actual flow down to 15% of the nominal flow. Total EAMS accuracy shall include and depend upon: temperature, compensation, humidity, repeatability, turbulence and placement. If required, field assembly and field calibration of the airflow measurement stations shall be the responsibility of the installing contractor.

3. Provide low leak face any bypass dampers as scheduled on drawings. Dampers shall be Ruskin CD60 double skin airfoil design or equivalent. Construct damper blades and damper frames of galvanized steel. Provide opposed blade action with metal

compressible jamb seals and extruded vinyl blade edge seals. Blades shall rotate on stainless steel sleeve bearings. Mechanically link face dampers to bypass dampers and provide end driven control shafts. Damper blade lengths shall not exceed 60 inches. Leakage rate shall not exceed 5 CFM/square foot at one inch water gage and 9 CFM/square foot at 4 inch water gage.

P. Access Sections:

1. Access for inspection and cleaning of the unit drain pan, coils and fan section shall be provided. The unit shall be installed for proper access. Procedures for proper access, inspection and cleaning of the unit shall be included in the maintenance manual. Access sections shall have double wall, hinged doors on one side of sections.

   a. To facilitate inspection of internal components, provide sealed glass view windows on access doors accessing moving parts.
   b. Provide marine lights inside access sections. Construct marine lights of sealed glass fixtures with wire guards to deep electrical sockets dry and protect fixtures from damage.

Q. General Sections:

1. Air Blender: The blender shall be of the rotary design with radial blades. Blender section shall have the proper distances upstream and downstream to provide a minimum mixing effectiveness of 75 percent when mixing 50 percent outside air and 50 percent return air at 50 F initial inlet temperature differential. Casing shall be construced per Article 2.04 Paragraph A-H. Insulation shall be per Article 2.04, Paragraph A. Access doors shall be provided on [ACCESS DOORS PLACEMENT] sides of section [doors shall be constructed per Article 2.04 paragraph C].

2. Moisture Eliminator: Provide moisture eliminator with galvanized sine wave fins and drain pans in the casing.

3. Diffuser: Provide a diffuser section as shown on the drawings to promote equal air distribution across coils and filters.

R. Integral Face and Bypass Coil:

1. Heating coil shall be hot water and shall be provided as shown on the drawings and schedule. Each heating coil is to consist of built-in series of finned heating elements and bypasses with interlocking dampers. Each coil shall be capable of maintaining a constant discharge air temperature regardless of variations in entering air temperature with full steam pressure or full hot water flow on the coil at all times.
2. Proportioning of the air shall be that the temperature at any point in a plane parallel to the leaving side will not vary more than 5 degrees F from the average discharge temperature. The IFB coil section shall have the required space between the leaving side and the entering side of any downstream coils for this application as recommended by coil manufacturer.

3. Dampers shall be 16 gauge roll formed, cold rolled galvanized steel. Finned heating elements shall be fabricated of seamless return bend type copper tubes with rectangular aluminum fins spaced not closer than 12 fins per inch. Finned elements shall be factory tested at 200 psi steam and 1000 lbs hydrostatic pressure.

S. Roof Curb: Provide a roof curb designed to support the unit on the roof. The curb shall compensate for any structural roof slope and shall accommodate any sloped insulation. The curb shall be a minimum of 12” above the finished roof at any point.

2.3 INDOOR AIR HANDLING UNITS:

EDIT NOTE: THE FOLLOWING IS BASED ON TRANE MCC INDOOR UNIT.

A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current ARI 410 standard.

B. Certify air-handling units in accordance with ARI 430.

C. Provide one set of extra filters and one set of belts for each air handler.

D. The equipment manufacturer shall provide, at no additional cost, a standard parts warranty the covers a period of one year from unit start-up. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

E. Unit Casing:

1. Unit shall be constructed of a complete structural frame with removable panels. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTMB 117 250-hour salt-spray test. The removal of side panels shall not affect the structural integrity of the unit. All removable panels shall be gasketed to minimize air leakage. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

2. Access panel and/or access doors shall be available on both sides of the unit in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection and maintenance. If panels are not removable, then manufacturer shall provide access sections with doors between all internal components to ensure access and cleanability of the air handler.

3. Access doors shall be double wall construction to prevent damage to insulation during routing maintenance.

4. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of all interior surfaces.

5. Door hardware shall be surface mounted to minimize penetrations in the door casing that could lead to air leakage paths.

6. All joints between exterior panels and structural frames, as well as joints between module frames, shall be properly sealed and gasketed to provide an air seal.

7. Insulation – high density, matte-faced-interior surface of unit casing shall be acoustically and thermally lined. Insulation shall be installed with adhesive. Insulation shall have a minimum R-value of 4 and shall be UL listed. The installation shall comply with NFPA 90A and B requirements. If edges of fiberglass insulation are exposed, the manufacturer shall be responsible for sealing exposed edges with mastic sealer to prevent erosion into the air-stream.

8. To facilitate inspection if internal components, provide sealed tempered glass view windows in doors accessing moving parts.

9. Provide marine lights in all sections. Marine light shall be UL listed for wet locations. Light shall be complete with bulb and junction box.

10. Provide concrete 4" housekeeping pad under casing. Isolate unit form pad with [rubber gasket] [3/4" rubber waffle pad] [full perimeter spring rail].

F. Fans:

1. Provide [DWDI FC] [DWDI BI] [DWDI BIAF] [plug type] supply fans. Provide [DWDI FC] [DWDI BI] [DWDI BIAF] [plug type] return fans. Fan shafts shall be solid, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment as speeds between 25% and 100% of design RPM. If fans are not factory-tested responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

2. When plug fans are used, provide door switches for fan shut-down when access door is opened.

3. Provide grease lubricated ball bearings selected for L-50 400,000 hour average life per ANSI/AFBMA 9. Greasable bearings shall have lubrication lines extended to the drive side of the unit. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. Extend both grease lubrication lines to drive side of unit and rigidly attach to drive side bearing support with zerk fittings. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.

4. Fans shall be mounted on [inertia base] isolation bases. Internally mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Flexible canvas ducts shall be installed between fan and unit casing to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A and UL 181 requirements.

5. Fan modules shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

6. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker form accidental contact with the belts and sheaves.

7. Motors and Drives:

   a. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change.
   b. V-belt drives shall be [constant] [fixed] pitch rated at 1.2 times the motor nameplate.

G. Coils:

1. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drainpan under the coil.

2. Coils shall be manufactured with plate fins to minimize water carryover and maximized airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across coils as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

3. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

4. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated in order to minimize the chance for water carryover.

5. On stacked cooling coils, intermediate drain pans shall be installed between the coils. Intermediate drain pans shall have drop tubes to guide condensate to the main drain pan, thus preventing flooding of lower coils that would result in moisture carryover.

6. Hydronic Coils:

    a. Supply and return header connections shall be clearly labeled on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.

    b. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.

    c. Headers shall be constructed of round copper pipe or cast iron.

    d. Tubes shall be ½ inch O.D. minimum 0.016 inch thick copper. Fins shall be aluminum.

    e. 10 fins per inch maximum.

    f. 500 FPM maximum velocity for hydronic coils

    g. 700 FPM maximum velocity for heating coils.

    h. Minimum 6 row cooling coil

    i. Minimum 3 FPS water velocity for chilled water coils.

    j. Minimum 1.5 FPS water velocity for constantly pumped chilled water coils.

    k. Minimum 1.5 FPS water velocity for hot water coils

    l. Minimum 0.75 FPS water velocity for constantly pumped hot water coils.

7. Steam Heating Coils:

a. Steam supply, condensate return and vacuum breaker connections shall be clearly labeled on outside of units.

b. Coils shall be non-freeze steam distributing type. Coils shall be pitched in units for proper drainage of steam condensate from coils.

c. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.

d. Headers shall be constructed of round copper pipe or cast iron.

e. Tubes shall consist of 5/8 inch O.D. minimum 0.035 inch thick copper inner tubes and 1 inch O.D. minimum 0.031 inch thick copper outer tubes. Fins shall be aluminum.

f. Inner tubes shall have orifices that ensure even steam distribution throughout the length of the outer tube. Orifices shall direct steam toward return connections to ensure steam condensate is properly drained from coils to prevent flashing of condensate.

8. Refrigerant Cooling Coils:

a. Refrigerant suction and liquid connections shall be clearly labeled on outside of units.

b. Coils shall be proof tested to 450 psig and leak tested to 30 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen, and sealed to prevent contamination.

c. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.

d. Tubes shall be ½ inch O.D. minimum .016 inch thick copper. Fins shall be aluminum.

e. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

9. Integral Face and Bypass Coils (IFB)

a. Heating coil shall be hot water and shall be provided as shown on the drawings and schedule. Each heating coil is to consist of built-in series of finned heating elements and bypasses with interlocked dampers. Each coil shall be designed to maintain a constant discharge air temperature regardless of variations in entering air temperature with full steam pressure or full hot water flow on the coil at all times.

b. Coil shall be designed to maintain no more than a 5 degree F variance from the average discharge air temperature to minimize air stratification. The air handler shall have sufficient space downstream of the IFB coil as recommended by the IFB coil manufacturer to minimize stratification.

c. Dampers shall be galvanized steel. All bearings, seals, damper blades and linkage operation shall not be impaired by the high temperature associated with

operation of the IFB coil. Finned elements shall be factory tested at 200 psi steam and 1000 lbs hydrostatic pressure.

H. Base-Level Drain Pans:

1. Insulation shall be encased between exterior and interior walls. Units with cooling coils shall have drain pans under complete cooling coil section that extend beyond the air-leaving side of the coil to ensure capture of all condensate in section. Cooling coil drain pans shall be sloped in 2 planes, pitched toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's requirements. See section 2.05, paragraph E for specifications on intermediate drain pans between cooling coils.

2. Units with heating coils shall have a drain pan under complete heating coil section sloped in 2 planed and pitched toward drain connections to ensure proper drainage during cleaning and to capture water in the event of a coil failure.

3. All drain pan connections supplied by unit manufacturer including, piping and piping connections extending from stainless steel drain pans shall be constructed of stainless steel. The contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

4. Flat drain pans shall be acceptable in sections that may have incidental, but not continuous contact with moisture. Flat drainpans shall be accessible for cleaning.

I. Filters:

1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double-wall, hinged doors for filter removal. Filter sections shall flange to other unit components. Provide filter blockoffs as required to prevent air bypass around filters.

2. Provide 2 inch Merv 8 flat filter sections with throwaway filters. Filters shall be removable from one side(s) of filter sections.

3. Provide high efficiency filter sections with 12" cartridge filters. High efficiency filters shall be Merv 14 efficient and rated in accordance with ASHRAE 52 and UL class 1 or class 2. Filters shall be removable from one side of filter sections.

4. Provide HEPA final filter section with maximum face velocity of 500 fpm. HEPA filter section shall have negligible bypass. HEPA filters shall be 99.97% efficient when tested with 0.3 micron thermally generated particulates. Filters shall be housed in rear loading type filter rack.

J. Dampers:

1. All dampers, with the exception of external bypass and multi-zones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as scheduled. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 5 CFM/square foot at one inch water gauge and 9 CFM/square foot at 4 inch water gauge. All leakage testing and pressure ratings shall be based on AMCA publication 500. Manufacturer shall submit brand and model of damper(s) being furnished.

K. Access Sections:

1. Access for inspection and cleaning of the unit drain pan, coils and fans sections shall be provided. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be included in the maintenance manual. Access section shall have double wall, hinged, removable access doors on one side of section. Construct doors per section 2.03 paragraphs D, E and F.

2. To facilitate inspection of internal components, provide sealed tempered glass view windows in access doors accessing moving parts.

3. Provide marine lights in sections as specified on schedule. Marine light shall be UL listed for wet locations. Light shall be complete with bulb and junction box.

L. General Unit Sections:

1. Air Blender: The blender shall be of the rotary design with radial blades. Blender shall have the proper distances upstream and downstream s recommended by the blender manufacturer. Minimum mixing effectiveness shall be 75 percent when mixing 50 percent outside air and 50 percent return air at 50 F initial inlet temperature differential. Construct blender of .080 aluminum.

2. Moisture Eliminator: Provide moisture eliminator with galvanized fins and drain pan in the casing.

3. Internal Face and Bypass Section: Provide an internal face and bypass section as shown on the drawings. Construct dampers per units provided with coil immediately downstream of bypassed coil shall be provided with space equivalent to bypassed coil height or greater to insure full face activation of downstream coil.

4. External Face and Bypass Section: Provide an external face and bypass section as shown on the drawings. Contractor shall be responsible for construction of bypass duct, including fabrication, installation and fabrication of return opening into unit. Manufacturer shall provide calculations for determining required opening to return bypass air back into unit.

5. Diffuser Section: On units provided with coils or filters immediately downstream of double inlet housed centrifugal fans, provide a factory mounted diffuser section as shown on the drawings to promote equal air distribution.

6. Acoustical Attenuator: Provide factory mounted sound attenuation section(s). Attenuation section(s) shall be made of double wall construction with minimum 20 gauge galvanized perforated steel liner. Acoustical attenuator(s) length shall be sized to meet discharge sound power levels as defined in schedule. Space shall be provided both upstream and downstream of attenuator section(s) as required by attenuator manufacturer to insure smooth transition of airflow into and out of attenuator.

7. Energy Wheel Section:

   a. The air handling unit shall have a total energy wheel sized per the ventilation requirement as defined on the schedule. The energy wheel shall be an integral part of the air handling unit. Unit shall be installed as a complete system with assembled and ducted energy recovery device. Manufacturer shall include performance information in the submittal that meets or exceeds scheduled wheel performance.

b. Energy wheel shall be sized to handle minimum OA ventilation requirement as defined on schedule. Energy wheel shall be capable of 100% economizing. Wheel section shall include variable effectiveness damper. On mixed air units, the return damper shall be an integral part of the energy wheel section and shall be sized for adequate mixed air control.

c. The air handling unit shall be certified by ARI to contain a rotary energy recovery wheel that is ARI 1060 certified. The air handling unit nameplate shall bear the ARI 1060 certification nameplate shall bear the ARI 1060 certification label. Performance characteristics of the energy wheel shall be provided as defined by ARI 1060. The energy wheel shall be an enthalpy wheel capable of sensible and latent heat transfer. Sensible, latent and total net effectiveness of the wheel performance shall meet or exceed performance as defined on schedule. The calculated total net effectiveness of the recovery device shall not be less than 70 percent when the specified ventilation flow rate equals the exhaust flow rate. Wheel face velocity and pressure drop shall not exceed performance as defined on schedule. The energy recover cassette shall be an Underwriters Laboratories (L) recognized component certified for mechanical, electrical and fire safety in accordance with UL standard 1812.

d. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belts. The total energy recovery wheel shall incorporate a desiccant without the use of binders or adhesives, which may plug the desiccant aperture. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim and to minimize wear of components. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self adjusting; diameter seals shall be self adjustable. Seals shall be factory set. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.

e. The wheel drive motor shall be provided, mounted in the cassette frame and supplied with a connector for field service. The wheel drive motor shall be thermally protected and UL component recognized. On units that require drive belt tensioners for the wheel belt/motor assembly, the wheel manufacturer shall provide at no additional charge to the customer a visual inspection every four months, and adjustment if necessary, of the recommended belt tension during the unit warranty period. The wheel drive motor shall be no greater than 0.33 hp and shall be the same voltage as the airhandler fan motors.

f. Energy recovery media for wheels larger than 25 inches in diameter shall be provided in the form of removable segments. The segments shall be removable without the use of tools to facilitate maintenance and cleaning as required. Coated segments shall be washable using standard detergent or alkaline-based coil cleaners. The desiccant shall not dissolve in the presence of water or high humidity.

g. Access doors shall be provided on all air entering and air leaving sides of wheel to allow for wheel maintenance, belt or motor removal.

8. Air to Air Heat Exchanger Section

a. The heat exchanger shall be a cross flow, aluminum plate type exchanger. The aluminum plates shall be die formed from 99.9% pure aluminum with a plate profile that maximizes efficiency and cleanability and minimizes pressure loss. The connection plate edges shall be double-folded and sealed internally with a

synthetic resin. The plate core shall be assembled into a strong, self supporting frame made of aluminum corner extrusions and galvanized steel end plates. Access to all four sides of the exchanger for cleaning and inspection shall be provided.

b. Air handling unit shall be configured to allow for inspection and cleaning of all four air paths of plate heat exchanger.

c. The heat exchanger shall meet the performance as shown on the schedule. No frost control or bypass dampers are required.

9. Humidifier Section:

a. Manufacturer shall provide factory packaged steam injection type humidifier. Humidifier shall include a fabricated separator/header and multiple dispersion tube with all wetted parts constructed of stainless steel. Separator/header shall include a pipe-within a pipe design to insure proper separation and drainage of condensate for units supplying 5,000 CFM or more. Below 5,000 CRM, separator/header shall have a single pipe design. All active tube-to-header joints are welded. No O-rings or slip couplings are acceptable. Active tubes are unjacketed so no air stream heat gain takes place when the humidifier is not in use. Active tubes are internally fitted with a series of stainless steel tubelets which extend into the center of the tube. Tubelets are sized and spaced to accept steam from the seapartor/header and provide a dry and uniform discharge of steam. Unit manufacturer shall provide sufficient absorption space upstream/downstream of humidifier as recommended by humidifier manufacturer.

b. The humidifier shall include steam specialties required to meet scheduled performance. Steam specialties shall include a steam control valve, inverted bucket trap and steam supply strainer that will ship with unit for installation by piping contractor. All pipe connections shall be made from one side of the casing section.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF AIR HANDLING UNITS:

A. General: Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of air handling units with other work.

C. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

D. Support: Install floor-mounted air handling units on 4" high reinforced concrete pad, a minimum of 4" larger on each side than unit base.

E. Support: Install roof-mounted air handling units on roof curb. Anchor unit to curb with removable fasteners.

F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

G. Piping Connections: Refer to Division-15 HVAC sections. Provide piping, valves, accessories, gauges, supports, and as indicated.

1. Provide flexible connectors shutoff valves, balancing valves, unions, thermometers (supply and return), P & T types (supply & return) and other accessories on all piping connections.

H. Duct Connections: Refer to Division-15 Air Distribution sections. Provide ductwork, accessories as indicated.

I. Grounding: Provide positive equipment ground for air handling unit components.

3.3 FIELD QUALITY CONTROL:

A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

3.4 EXTRA STOCK:

A. Provide one complete extra set of filters for each air handling unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

B. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

3.5 TRAINING:

A. Schedule a minimum of 4 hours of training with Owner. The manufacturers representative, and the Division 15 contractor shall be present. The training shall be coordinated by the Division 15 contractor and the Owner in conjunction with the other mechanical equipment on the project.

B. Training:

1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the contents of the Operating and Maintenance Data specified in Division 1 and Section 15010.

2. Schedule training with Owner through the Architect/ Engineer with at least 7 days prior notice.

END OF SECTION 15855