

## SECTION 236000 - EQUIPMENT

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. This Section covers HVAC systems and equipment.
- C. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification.

#### 1.2 QUALITY ASSURANCE

- A. Conform to the following:
  - 1. North Carolina State Electrical Code-2017.
  - 2. North Carolina State Energy Conservation Code-2018.
  - 3. North Carolina State Mechanical Code-2018.
- B. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Refer to Section 231000, Piping, Valves and Accessories, and requirements specified herein.
- C. Provide a complete parts and labor warranty, including refrigerants and lubricants, for 1 year after date of substantial completion, for the following equipment:
  - 1. Air-cooled chillers.
  - 2. Rooftop air conditioning units.

### PART 2 - PRODUCTS

#### 2.1 COILS

- A. Copper tubes, and nonferrous fins with belled collars mechanically bonded to the tubes.
- B. Cooling coils: 0.024" wall thickness and 0.009" fin thickness, designed for counterflow of water to air.
- C. Multirow hot water coils: designed for parallel flow of water to air.
- D. Supply and return connections shall be on the same end.
- E. Performance shall be in accordance with AHRI 410-2001 (with Addendum).
- F. Minimum working pressure rating shall be equal to that specified herein for the piping system in which the coil is installed. Coils shall be tested at the rated working pressure plus 50%.

## 2.2 AIR-COOLED CHILLERS

- A. Packaged, air-cooled type, designed and constructed in accordance with ASHRAE 15-2019, complete with refrigerant, compressors, motors, evaporator, condenser, insulation, controls, motor controller, control panel, mounting base, enclosure, and associated equipment. Enclosures constructed of steel shall be protected with a corrosion resistant coating suitable for coastal area.
- B. Rating certification: capacity rating shall be certified in accordance with AHRI 550/590-2018 (Errata). Submit chiller performance data directly from the manufacturer's selection software annotated with a statement of AHRI compliance and including software version number, chiller model number, refrigerant, net refrigeration capacity, water flow rate, pressure drop, entering and leaving water temperatures, power input, ambient condition, fouling factors, and voltage. Performance shall be provided at the full load design condition and each of the NPLV part load conditions.
- C. Compressors shall be one of the following types:
  - 1. Scroll type, including centrifugal oil pump. Compressors shall cycle to meet demand. Chillers greater than 35 tons shall have a minimum of 2 refrigerant circuits.
  - 2. Digital scroll type, including solenoid valve and variable cycle time to allow continuous capacity reduction from 100% to 10% load.
  - 3. Rotary screw type, complete with positive pressure oil lubrication system, oil heater, and automatic capacity reduction system with automatic unloading on start-up. Compressors shall fully modulate from 100% to 10% of design capacity.
- D. Evaporators: shell and tube or brazed-plate constructed for 150 psig waterside rating, covered with 1.5" thick flexible elastomeric sheet, vapor barrier insulation; protected against freeze-up by a thermostat-controlled temperature maintenance cable wrapped around the shell under the insulation. Fouling factor shall be 0.0001 ft<sup>2</sup>·°F·h/Btu.
  - 1. Evaporators for variable chilled water flow shall be certified by the manufacturer to operate with the minimum chilled water flow indicated on the Drawings.
- E. Refrigerant circuits: high side pressure relief valve, service isolation valves, filter drier, moisture indicating sight glass, liquid line solenoid valves, insulated suction lines, and thermal expansion valves.
- F. Condensers: vertical discharge with safety guard. Coils shall have copper tubes and aluminum fins, single piece aluminum construction, or aluminum alloy microchannel.
  - 1. Entire coil, including tubes, fins, and frame shall be coated with a corrosion resistant coating suitable for coastal area.
- G. Motor controllers: wye-delta motor starter or variable frequency drive. Controllers and components, excluding evaporator heater, shall be factory-wired for a single-point field power connection.
  - 1. Controllers shall include:
    - a. Non-fused disconnect switch or non-automatic circuit breaker, with door interlocked externally-operable handle, capable of being pad locked. Electrical lugs shall be sized for the incoming power wiring.
    - b. Short-circuit rating of 65,000 A.
    - c. Control power transformers for controls and accessories.
    - d. Short circuit, motor overload, and ground fault protection.
    - e. Phase failure and low voltage protection.
- H. Control panels: unit-mounted in a weather-tight enclosure with microprocessor-based operating and safety controls, graphic display and keypad, with monitoring capabilities, programmable setpoints, and building control system interface. Panels shall include the manufacturer's standard control package with accessories as required to provide the following functions:

1. Leaving chilled water temperature control.
2. Graphic display of the following items, including factory-wired devices and sensors:
  - a. Chilled water temperature entering and leaving evaporator.
  - b. Evaporator refrigerant pressure and temperature.
  - c. Condenser refrigerant pressure and temperature.
  - d. Ambient temperature.
  - e. Oil pressure.
  - f. Oil temperature.
  - g. Motor current % of rated load amperes.
  - h. Input power (kW).
  - i. Operating hours.
  - j. Diagnostic messages.
3. Communication interface to transmit operating data and receive commands through a single connection to the building control system. The interface shall include hardware and software coordinated with the building control system that allows monitoring and control of data and alarms available at the control panel from the BCS. Communication protocol shall be BACnet, LonWorks, or Modbus as coordinated with the building control system supplier. Information transmitted and received shall include:
  - a. Digital inputs from the building control system:
    - 1) Chiller enable/disable.
  - b. Analog inputs from the building control system:
    - 1) Chilled water reset.
    - 2) Electric power demand limit.
  - c. Digital outputs to the building control system:
    - 1) Chiller status.
    - 2) Chiller master alarm indicating shutdown due to safety controls.
  - d. Analog outputs to the building control system:
    - 1) Running amperes as a percentage of rated load amperes.
    - 2) Chilled water setpoint.
    - 3) Current limit setpoint.
- I. Evaporator differential pressure switches: opposed-diaphragm type, with magnetically actuated adjustable switches, dial type differential pressure readout, and isolation and null valves, selected to operate in the top 80% of the range at the differential pressure corresponding to minimum allowable evaporator flow. Switch shall not drop out at differential pressures that exceed the range. Maximum line pressure shall exceed the operating pressure of the installed system.
  1. Manufacturer: Orange Research 1516 DGS series.
- J. Enclosures: factory-mounted louvered panels which shall completely screen from view and protect condenser coils, compressor, wiring and louvers.
- K. Chiller manufacturer shall coordinate and approve controls provided in Section 238000, Automatic Temperature Controls, and shall indicate such approval in writing on the control shop drawing submittal.
- L. Written instructions and control diagrams showing wiring and programming for building control system interfaces shall be furnished by the manufacturer to be incorporated in the control diagrams specified in Section 238000, Automatic Temperature Controls.
- M. Manufacturer: Daikin, Trane, or York.

## 2.3 TERMINAL UNITS

### A. Casings:

1. Minimum 24 gauge galvanized steel.
2. Acoustical lining: minimum 0.5" thick, 1.5 pcf density coated fiberglass. Lining shall meet erosion test method described in UL 181-2013 and shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018.
3. Access doors: sealed, flush type for access to internal parts for service or maintenance.
4. Enclosure: removable type for control components.
5. With four angle or heavy gauge hanger brackets for units indicated on the Drawings to be suspended with vibration isolators.
6. Casing leakage rate of less than 3% at 4" wg.
7. Inlet velocity shall not exceed 2200 fpm.

### B. Control Motors:

1. Factory-installed on units by unit manufacturer.
2. Coordinated with automatic control system manufacturer; see Section 238000, Automatic Temperature Controls.

### C. Airflow sensors: averaging multipoint type, with taps for field calibration, minimum $\pm 5\%$ accuracy with 90° elbow at inlet.

### D. Volume Regulators:

1. Factory preset: minimum and maximum air quantity. Air volumes and unit size shall be indicated on the regulator.
2. Gauge taps and calibrated means of adjustment to permit field adjustment of air quantities without unit disassembly.
3. Pressure independent, capable of maintaining constant volume,  $\pm 5\%$ , up to 4" wg inlet air pressure.
4. Factory-mounted.
5. Removable.

### E. Depth of units: 20" maximum.

### F. Moving parts designed for minimum of 300000 cycles.

### G. Heating Coils:

1. Electric, labeled as a complete assembly with the terminal unit per UL 1995-2015 or ETL listed to comply with the requirements of UL 1995-2015, complete with unit-mounted terminal box with hinged cover, silicon controlled rectifier (SCR) controls, and intermediate coil supports.
2. Heating elements, exposed element type:
  - a. Nickel chrome (80% nickel, 20% chrome) coiled wire, with minimum 1 wire diameter open space between adjacent coils.
  - b. Maximum wire density: 37 W/in<sup>2</sup>.
  - c. Maximum wire surface temperature: 1400°F.
3. Coils rated more than 48 A shall have heating elements subdivided. Each subdivided load shall not exceed 48 A and shall be fuse protected.
4. Provide a wiring diagram showing terminal designations of power and control circuits, mounted inside the terminal box.
5. Integral terminal boxes shall include:
  - a. Terminal blocks for line feeder and control connections.
  - b. Incoming line fuses for ungrounded conductors.

- c. Control circuit transformer with fused primary 24 V secondary unless otherwise specified herein.
    - d. Automatically reset thermal cutouts for primary over-temperature protection.
    - e. Manually reset thermal cutouts, load carrying type, for secondary over-temperature protection.
    - f. Contactors. Controlling and back-up contactors shall be magnetic. Back-up contactors shall break ungrounded conductors.
  - 6. Controls:
    - a. Coil shall be interlocked with fan by pressure differential air flow switch.
    - b. Analog input for modulating control of SCR heating.
    - c. Steps of heat shall be operated with contactors.
  - H. Sound Power Level Performance:
    - 1. Terminal unit casing radiated and discharge sound power levels shall be tested in accordance with AHRI 880-2017 and shall be certified by AHRI.
    - 2. Maximum allowable casing radiated and discharge sound power levels are scheduled on the drawings.
      - a. If needed to achieve the scheduled discharge sound power levels, the manufacturer may provide supplemental sound attenuators at the unit discharge and, in the case of fan-powered terminal units, at the unit's plenum return opening(s). Calculations demonstrating the overall terminal unit and attenuator(s) assembly performance shall be provided with the equipment submittal.
  - I. Variable Volume Units:
    - 1. Complete with:
      - a. Air valve assembly, normally open.
      - b. Variable air volume from maximum of 100% to minimum of approximately 0%.
      - c. Units shall be factory-wired for a single electrical connection point, including input fuses, single disconnect switch for heating coil, and transformers.
  - J. Fan-Powered Units:
    - 1. Complete with:
      - a. Air valve assembly, type as indicated on the Drawings.
      - b. Parallel type: air valve and fan in parallel with backdraft damper on fan, and baffles to prevent stratification. Intermittent fan operation.
      - c. Series type: air valve and fan in series. Constant fan operation.
      - d. Forward-curved fan with positive means of volume control.
      - e. 1" thick throw away filter and clips on return air opening.
      - f. Permanent lubricated split capacitor 3-speed motor with speed changing taps or permanent lubricated motor with electronic speed controller, thermal overload protection, fan motor controller, transformer, disconnect switch, and wiring.
      - g. Units shall be factory-wired for a single electrical connection point, including input fuses, single disconnect switch for both fan and heating coil, and transformers.
  - K. Manufacturer: Johnson Controls, Krueger, Metal\*Aire, Nailor, Price, Titus Trane
- 2.4 AIR HANDLING UNITS
- A. General, except as otherwise specified herein:

1. AHU-1-1 can be a custom or modular AHU. The performance criteria must all be met below, as well as schedule and dimensioned on the drawings.
  2. Complete with fan, motor, drive, coils, access sections, discharge plenum, and filters housed in a finished solid double-wall casing with thermal insulation and drain pan. Functional components shall be accessible for inspection and maintenance through hinged, solid double-wall access doors in each section. Piping connections shall extend through the casing. Unit performance for standard and modular units shall be certified in accordance with AHRI 430-2014 Addendum 1. Unit performance for custom units shall be ETL listed and labeled.
  3. Fans:
    - a. Tested in accordance with ASHRAE 51/AMCA 210-2016.
    - b. Statically and dynamically balanced. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.
    - c. Bearings: pillow block or flange type with  $L_{10}$  life of 80000 hours at the peak operating condition. Extend grease leads to allow lubrication during inspection on the access side.
    - d. For housed centrifugal fans in draw-through units, fan wheel rotation shall be in the same direction as flow in elbows installed within 3 duct diameters of the fan discharge, where discharge from the elbow is perpendicular to the fan shaft.
  4. Cooling coils: chilled water type, as specified in Paragraph 2.1, Coils.
  5. Heating coils: electric type, as specified in Paragraph 2.11, Electric Heating Coils.
  6. Filters: Panel style rigid filters.
  7. Internal vibration isolation: at Contractor's option, internal vibration isolators may be provided in lieu of external isolators. Fan and motor shall be mounted on a common steel vibration base. Fans shall have a flexible connection to the casing. Internal vibration isolators shall be as specified in Section 230010, HVAC General, and as indicated on the Drawings.
  8. Drives: Direct Drive.
  9. Motors: as specified in Section 230010, HVAC General.
  10. Variable frequency drives: as specified in Section 23 00 10, HVAC General.
  11. Control dampers: as specified in Section 238000, Automatic Temperature Controls.
  12. Drain pans: double-wall stainless steel construction with insulation sandwiched between inner and outer pans. Corners shall be welded. Pans shall be pitched toward drain outlet. Units with stacked coils shall include a secondary drain pan under each coil with drain piping to main pan.
  13. Double-wall casing insulation: 2" thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft<sup>2</sup>·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018.
  14. The following coastal requirements shall be provided for air handling units AHU-1-1
    - a. Corrosion resistant coating suitable for coastal area for cooling coils.
    - b. Cooling coil sections with stainless steel hardware, including, but not limited to, tracks, liners, and tube sheets.
    - c. Fans with corrosion resistant coating suitable for coastal area and stainless steel drive shafts.
    - d. Totally enclosed, fan-cooled motors.
    - e. Filter sections with stainless steel hardware, including, but not limited to, racks, frames and liners.
- B. Other Draw-Through Type Units:
1. Manufacturer: Daikin, Johnson Controls/York Solution, or Trane.
- C. Custom Type Units:
1. Custom type, with assembly of units not factory-assembled supervised and certified by the manufacturer.
  2. Fans: protected against corrosion.
  3. Bearings: pillow block or flange type with  $L_{10}$  life of 80000 hours at the peak operating condition.

4. Sound power levels, in dB re  $10^{-12}$  watts, at inlet or outlet duct connections and adjacent to unit in equipment room, at maximum rated conditions, as determined in accordance with AHRI 260-I-P 2017, shall not exceed the following values:

	Frequency (Hz)				
	125	250	500	1000	2000
Outlet/inlet connections					
Casing radiated					

5. Internal vibration isolation: fan and motor shall be mounted on a common steel vibration base, mounted on vibration isolators, as specified in Section 230010, HVAC General, and as indicated on the Drawings. Fans shall have a flexible connection to the casing.
6. Filters: bag type, as specified in Section 237000, Air Distribution.
7. Control dampers: where indicated on the Drawings, and as specified in Section 238000, Automatic Temperature Controls.
8. Smoke, dampers: where indicated on the Drawings, and as specified in Section 237000, Air Distribution.
9. Casings: designed to withstand 10" wg positive and negative pressure with maximum 1% leakage and maximum 0.25" deflection in 10' span. Floor construction shall include structural reinforcement to support internal equipment plus two 250 lb maintenance workers in each plenum. Panels shall be 4" thick with 18 gauge galvanized exterior sheeting and 22 gauge solid inner liner. Insulation shall be 4" thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft<sup>2</sup>·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018. Inner surfaces shall be smooth and accessible for cleaning. Provide hinged, double-wall access doors with view windows on each side of each service plenum and at locations indicated on the Drawings. Provide sleeves through casing wall for piping, wiring and controls. Hardware, fasteners and miscellaneous materials shall be corrosion resistant. Assembled unit or each section of sectional units shall be provided with lifting lugs.
10. Drain pans: constructed of type 304 stainless steel, sloped to provide positive self-drainage, with drain opening easily accessible for cleaning. Units with stacked cooling coils shall include a secondary drain pan under each coil with drain piping to main pan. Drain pans shall extend upstream and downstream as necessary to prevent wetting of service plenums or carryover of moisture droplets at 450 fpm cooling coil face velocity. Provide auxiliary drain pans or flashing to prevent wetting of unit floor from condensation on cooling coil return bends, piping or other cold surfaces within the unit.
11. Floor construction: 12 gauge steel, corrosion protected after fabrication, with nonskid walking surface.
12. Washdown plenums: inner liner in plenums upstream and downstream of cooling coils shall be 22 gauge solid stainless steel, with drain for washdown.
13. Access doors: 18 gauge inner and outer panels, overlapping seal type with double continuous air/acoustic seals around the sill, jambs, and head. Minimum of 2 wedge lever type latches and 3 butt or ball bearing offset type hinges per door.
14. Coil piping: from cooling coils to connection point outside the exterior casing, with flange or union at each coil connection and vent and drain valves at each coil inside the unit.
15. Marine lights: in each service plenum, with switch and indicator light at each door.
16. Electrical utility outlets: weatherproof GFCI type in each equipment service plenum and on each side of the exterior casing.
17. Fan vibration safety switches: at each fan, arranged to stop fan operation and alarm through the BCS and energize a warning light outside the fan plenum.
18. Control damper actuators: as specified in Section 238000, Automatic Temperature Controls.
19. Other control system components: install control devices located within the casings, as described in Section 238000, Automatic Temperature Controls. Coordinate type and characteristics of devices with the controls subcontractor.

20. Electric control wiring: termination panels with terminal strips on exterior of casing, with wiring to each sensor and control component located within the unit. Wiring shall be in accordance with Section 238000, Automatic Temperature Controls.
21. Electric power wiring: from fan motors, marine lights, to junction boxes on exterior casing. Wiring shall be in accordance with Division 26.
22. Manufacturer: Buffalo, Tane Custom, Governair, Johnson Controls/York Solution Custom, or Environmental Air Systems

## 2.5 DUCTLESS SPLIT SYSTEMS

- A. Systems shall be commercial grade equipment, complete with an outdoor condensing unit, indoor fan-coil unit, refrigerant piping, and controls. Units shall be rated in accordance with AHRI 210/240-2017. Units shall be factory-charged with refrigerant R-410A. Systems shall operate as cooling only systems as indicated on the Drawings.
- B. Outdoor condensing units: factory-assembled, complete with compressors, condenser fans, condenser coils, motors, controls, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, refrigerant regulators, and controls.
  1. Compressors shall be variable speed scroll type. Compressor speed shall be varied between 5% to 100% speed in response to load variation. Compressors shall be equipped with crankcase heaters, high pressure safety switches, and internal thermal overload protection.
  2. Condenser fans shall be propeller type with variable speed digitally commutating motors.
  3. Condenser coils shall have copper tubes, and aluminum fins.
  4. Controls: microprocessor-based.
  5. Electric connections: single point 208 V, 3-phase.
- C. Indoor Fan-Coil Units:
  1. Ductless wall mounted type, factory-assembled complete with cabinet, fan, coil, air filter, condensate pan, integral condensate pump, and controls. Units shall be provided with supply and return grilles and shall be designed for installation on wall in a conditioned space.
  2. Filters: throw away type, as specified in Section 237000, Air Distribution.
  3. Controls: microprocessor-based.
  4. Electric connections: each fan-coil unit shall be single point connection.
- D. Refrigerant Piping:
  1. As specified in Section 231000, Piping, Valves and Accessories.
  2. Piping joints and headers shall be provided by the system manufacturer in order to provide balanced refrigerant flow, and to provide specified capacity and performance.
- E. Wall-mounted space temperature sensors: provide for all indoor fan-coil units with the following features:
  1. Thermistor type temperature sensor.
  2. Setpoint adjustment buttons.
  3. Backlit LCD display in English.
  4. Display of sensed room and set point temperatures.
  5. cooling set point range limits.
  6. Unoccupied mode with independent cooling and heating setup and setback set points.
  7. Buttons shall be capable of being disabled by maintenance personnel.
- F. Manufacturer: Carrier, Daikin, Friedrich, JCI/York, LG, Mitsubishi, or Panasonic.



## 2.6 ROOFTOP AIR CONDITIONING UNITS

- A. Packaged, air-cooled, variable volume draw-through type, complete with hermetic compressors, cylinder unloaders, suction and discharge service valves, spring vibration isolators, compressor ambient lockout, crankcase heaters, oil sight glass, refrigerant sight glass, refrigerant drier, thermostatic expansion valves, pressure relief valve or fusible plug, time delay between successive starts of each compressor, suction accumulator, manually reset low oil pressure cutout for each compressor, liquid line valve for isolating refrigerant charge in condenser, motor overload protector and winding thermostats, refrigerant solenoid valves, air-cooled condenser coils with guards, condenser fans and motors, evaporator coils, fans, motors, extended fan grease connections, filter section, and high and low pressure safety controls.
- B. Casings: weatherproof, galvanized steel construction with baked enamel finish, and a corrosion resistant coating suitable for coastal area. Sections and components shall be accessible through hinged access doors with neoprene gaskets. Casings shall be double-wall with solid inner panels and insulated with either a 2" **or 1"** thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft²·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018. Units shall be mounted on watertight curb units.
- C. Fans:
  - 1. Tested in accordance with ASHRAE 51/AMCA 210-2016.
  - 2. Statically and dynamically balanced. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.
  - 3. Bearings: pillow block or flange type with L<sub>10</sub> life of 80000 hours at the peak operating condition. Extend grease leads to casing exterior to allow lubrication during operation.
  - 4. In draw-through units with centrifugal fans, fan wheel rotation shall be in the same direction as flow in elbows installed within 3 duct diameters of the fan discharge, where discharge from the elbow is perpendicular to the fan shaft.
- D. Filters: Pleated type, as specified in Section 237000, Air Distribution.
- E. Dampers: as specified in Section 237000, Air Distribution.
- F. Condensers: selected for a condensing temperature not to exceed 120°F at 100°F ambient. Coils shall have copper tubes and aluminum fins, entire coil coated with a corrosion resistant coating suitable for coastal area.
- G. Variable volume features: variable frequency drives, as specified in Section 230010, HVAC General. Static pressure sensor for remote mounting in duct, and a static pressure controller mounted inside the unit control compartment, with a manahelic gauge connected to the static pressure sensing line and permanently mounted in an accessible location. Provide microprocessor-based leaving air temperature control including remote setpoint adjustment, adjustable reset rate (based on return air temperature), adjustable control band, and anti-frost control for the coil.
- H. Dry bulb temperature controlled economizer cycles: automatically modulated outdoor air damper, and fully modulated relief fan, in conjunction with refrigeration system controls, shall maintain space temperature. Relief fan shall be controlled and modulated in response to building pressure as sensed by a factory-installed differential pressure controller, set for 0.05" wg positive building pressure. Cycle shall be locked-out when outdoor temperature is too high for energy savings. Units shall have adjustable minimum position control and spring return damper.
- I. Constant outside air controls: automatically modulated return air damper to maintain mixing plenum static pressure as measured by a static pressure sensor in the mixed air plenum at the setpoint determined by the test and balance work shall maintain the minimum outside air quantity.
- J. Motors and starters: as specified in Section 23 00 10, HVAC General.

- K. Remote readout panels: 7 day programmable type with 6 hour battery back-up. Panel shall show operation of system-fan-cooling-heating, and dirty filters.
- L. Night setback thermostat and guard.
- M. Units shall be factory-wired to accommodate a single incoming main power feeder. Provide wiring diagram for isolating power circuit to evaporator fan, power burner and control circuit.
- N. Manufacturer: Carrier, Johnson Controls/York, or Trane.

## 2.7 WATER TREATMENT SYSTEMS

### A. Chilled Water Treatment Systems:

- 1. Bypass chemical feeders: steel construction, 5 gal capacity, with a pressure rating of 125 psig. Tank shall have inlet, outlet, and fill cap with minimum 3.5" opening.
- 2. Chemicals: shall conform to 21 CFR 173-2019.
- 3. Supplier: Anderson, Garratt-Callahan, GE Water and Process Technologies, Nalco, National Chemical, Superior, or Technical Specialties.

## 2.8 PUMPS

- A. End-suction, split-case back pull-out type, bronze-fitted, flexible-coupled, with bronze-sleeved or stainless steel shafts, mechanical seals designed for the pump service, bronze casing and impeller wear rings, shaft and coupling guard, and one-piece bronze impellers of nonoverloading type so motor nameplate rating shall not be exceeded at any point on the pump curve up to 125% of the flow indicated on the Drawings. Impellers shall be statically, dynamically, and hydraulically balanced. Casings shall have drilled and tapped vent and drain holes and air vent cocks.
  - 1. Each pump and motor shall be mounted on a common base of welded steel construction with grout holes.
  - 2. Bearings: ball type, grease lubricated, with fittings, designed for in-service lubrication or sealed for life, rated for a  $L_{10}$  life of 50000 hours at the maximum load scheduled on the Drawings.
  - 3. Motors: as specified in Section 230010, HVAC General.
  - 4. Impeller diameter shall not exceed 95% of the maximum impeller diameter available for the pump selection.
  - 5. For chilled water applications: galvanized drain pan, 16 gauge minimum with a 0.5" drain coupling.
  - 6. Manufacturer: Allis-Chalmers, Buffalo, Crane-Deming, Ingersoll-Dresser, or Peerless.
  - 7. Manufacturer: Armstrong, Bell & Gossett, PACO, Patterson, Pentair-Aurora, Taco, or Weinman.

## 2.9 ELECTRIC WALL HEATERS

- A. UL listed, wall type. Heating elements shall be the tubular finned metal sheath type with helical coiled fins. Heaters shall have automatically reset thermal overheat protection, power disconnect device or positive off switch, and shall be factory wired for a single point connection including power disconnect.
- B. Complete with: direct-drive propeller fan and permanently lubricated motor. Motor shall be permanent split capacitor type with built-in automatically reset motor overload protection.
- C. Enclosures, surface-mounted, 20 gauge steel, with horizontal inlet and discharge grilles, baked enamel finish, color selected by the Architect.
- D. Controls: self-contained internally wired thermostat with remote bulb in return air.
- E. Manufacturer: Berko NFR, Brasch SR, INDEECO, Markel 3420, Q-Mark A, or Raywall.

## 2.10 ELECTRIC FINNED TUBE RADIATION

### A. General:

1. Factory-assembled, wired and tested, UL listed.
2. Designed to eliminate 60 Hz sound.
3. High limit thermal cutout, automatic reset, linear full length type sensing bulb along entire length of heater. Self-contained thermostat for elements in each room.
4. Disconnect switch.
5. 2-stage control for 500 W/ft density and greater.
6. Heating Elements:
  - a. Nickel chrome (80% nickel, 20% chrome) coiled wire imbedded in magnesium-oxide refractory material and enclosed in sheath. Spirally wound steel fins furnace brazed to steel sheath, or aluminum fins mechanically bonded to aluminum or steel sheath.
  - b. Heat-resistant nonoxidizing finish on sheath and fins. Copper-plated, high temperature aluminum finish, or ceramic coating for corrosion protection.
  - c. Maximum 6 fins per in.
  - d. Support anchor with cushioned space for expansion.
  - e. Maximum surface temperature: 350°F.

### B. Commercial Draft Barriers:

1. Enclosures: 16 gauge steel.
2. Grilles: louvered 16 gauge stamped steel or 14 gauge extruded aluminum.
3. Finish: baked enamel, color as selected by the Architect.

### C. Architectural Draft Barriers:

1. Enclosures: sloped top, minimum 16 gauge extruded aluminum.
2. Grilles: minimum 16 gauge extruded aluminum.
3. Finish: baked enamel, anodized, color as selected by the Architect.
4. Provide pedestal mounts where indicated on the Drawings.

### D. Utility:

1. Designed for mounting in a soffit, with heavy duty expanded metal guard.

### E. Manufacturer: Berko, Brasch, Electromode, Erincraft, INDEECO, Markel, Q-Mark, or Raywall.

## 2.11 ELECTRIC HEATING COILS

### A. UL listed, complete with terminal box with removable cover on the end of the coil, intermediate coil supports, automatically reset thermal cutouts for primary over-temperature protection, heat limiters or manually reset thermal cutouts for secondary over-temperature protection, and pressure differential airflow switch. Arrange circuiting to prevent stratification of hot and cold air.

### B. Heating elements: either sheathed or exposed element type.

1. Sheathed Element Type:
  - a. Nickel chrome (80% nickel, 20% chrome) coiled wire imbedded in magnesium-oxide refractory material and enclosed in sheath. Spirally wound steel fins furnace brazed to steel sheath, or aluminum fins mechanically bonded to aluminum or steel sheath.
  - b. Heat-resistant nonoxidizing finish on sheath and fins. Copper-plated, high temperature aluminum finish, or ceramic coating.
  - c. Maximum 6 fins per in.

2. Exposed Element Type:
- a. Nickel chrome (80% nickel, 20% chrome) coiled wire, with minimum one wire diameter open space between adjacent coils.
  - b. Maximum wire density: 37 W/in<sup>2</sup>.
  - c. Maximum wire surface temperature: 1400°F.

- C. Coil dimensions shall be the same as the duct in which installed or opening to which attached.
- D. Coils rated more than 48 A shall have heating elements subdivided. Each subdivided load shall not exceed 48 A and each nongrounded conductor shall be fuse protected.
- E. Integral control boxes shall contain a terminal block and terminals sized for single incoming power feeder; control circuit transformer with fused primary and fused 120 V secondary; 100000 cycle service, 3-pole line break contactor for each circuit and fuses, housed in a NEMA 1 enclosure.
- F. Remote control cabinets shall contain a control circuit transformer with fused primary and 120 V secondary; 100000 cycle service, 3-pole line break contactor for each circuit; fuses for each circuit and separate terminal blocks and terminals for a single incoming power feeder and control circuits, housed in a NEMA 1 cabinet. Main busses and main lugs shall be sized for main feeder.
- G. Energize contactors through pilot duty devices, PE switches and multistep thermostats up to 3 steps, step controllers for more than 3 steps. Step controllers shall recycle on power interruption.
- H. Pipe pneumatic devices to bulkhead fittings on the side of the control box or cabinet.
- I. Provide a wiring diagram showing terminal designations of power and control circuits, mounted inside the control box or cabinet.
- J. Provide protective screens on entering and leaving air sides.
- K. Manufacturer: Brasch, INDEECO, Markel HF, or Nailor.

#### 2.12 CHILLED WATER BUFFER TANKS

- A. Vertical, steel construction, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for 125 psig working pressure, with base ring or structural steel legs with baseplates.
- B. Complete with manhole or inspection opening, air vent connection, lifting lugs, and bottom drain connection.
- C. Tanks shall have a vertical internal baffle to prevent stratification. Piping connections shall be as indicated on the Drawings.
- D. The exterior of the tanks shall be factory-painted with 2 coats of rust resisting paint.
- E. Insulation: factory-applied 0.75" flexible elastomeric sheet secured with full coverage of adhesive.
- F. Insulation: field-applied, as specified in Section 232500, Insulation.
- G. Manufacturer: Cemline, Lochinvar, Reco, Taco, or Wessels, or Wheatley.

## PART 3 - EXECUTION

### 3.1 CHILLERS

- A. Assembly shall be erected by trained mechanics in the employ of the manufacturer or under the supervision of an employee of the manufacturer in accordance with manufacturer's instructions.
- B. Provide ball valve on drain and vent connections on water boxes. Drain valves shall have hose end connections.
- C. Piping connections and control sequence shall conform to the manufacturer's specific requirements.
- D. Start-up service and commissioning shall be performed by mechanics retained by the manufacturer. Perform chiller commissioning and provide assistance and support during controls system commissioning. Submit a statement that the chillers are installed in accordance with the manufacturer's recommendations, and that safeties and controls are operating properly.
- E. Provide crossover pipe and connections between absorber and condenser shells of absorption chillers.
- F. Provide the services of a direct employee of the manufacturer to supervise the leak testing, evacuation, charging of the solution, and supervision of start-up.

### 3.2 TERMINAL UNITS

- A. Install terminal units with manufacturer's recommended upstream duct conditions for operation of velocity sensors and volume controls, and required clearances for control panels, coils, filters, return air openings, and other components.
- B. Install throw away filters while building is under construction. Upon completion of construction and final clean-up, remove these filters. and replace with a new set. and replace with 1" pleated filters.

### 3.3 AIR HANDLING UNITS

- A. For air handling units with coil sections that are near the floor, coordinate the unit mounting height with the condensate drain trap detail. If the bottom of the insulated drain trap conflicts with the floor slab, provide height adjustment supports between the air handling unit and housekeeping pad. Locate supports at manufacturer recommended load points.
- B. Custom units: units not factory-assembled shall be pressure tested in the field after installation. Unit casing leakage shall not exceed 0.5 cfm/ft<sup>2</sup> of casing area at a pressure of 5" wg.

### 3.4 PUMPS

- A. Furnish an extra set of mechanical seals for each pump and submit receipt acknowledging same.
- B. Provide base elbow supports for horizontal connections to base-mounted pumps.
- C. Install back pull-out type pumps with space and accommodations for back pull-out per the manufacturer's recommendations.
- D. Pump and motor alignment for each flexible-coupled pump shall be verified to be  $\pm 0.002$ " by the manufacturer after pump and piping have been installed and base has been grouted. Submit a written statement verifying completion and tolerance of alignment.

3.5 WATER TREATMENT SYSTEMS

- A. Systems shall include equipment, piping, fittings, installation, wiring and adjustments for manual operation as specified herein.
- B. Assist the building control system supplier with establishing remote monitoring of parameters as specified herein, including reasonable alarm values. Adjust the measurement range of analog outputs for conductivity and others based on expected operating conditions.

END OF SECTION 236000