

Montgomery County Public Schools Facilities Guide  
DIVISION 15 – MECHANICAL

## **SECTION 15103 HVAC EQUIPMENT**

### **PART 1 – GENERAL**

- 1.1 SCOPE: This Section details preferred product material and component requirements; product and system applications are described in other sections of this guide. It is recognized that deviations from the preferred materials and components can occur responsive to special circumstances.
- 1.2 CODES & STANDARDS: HVAC systems shall be designed in compliance with all codes and standards as cited previously.

### **PART 2 – PRODUCTS**

#### **2.1 Water Source Heat Pumps:**

##### **A. General:**

- 1. Heat pumps shall be geothermal water source design. Approved manufacturers are McQuay, Climate Master, Carrier, Florida Heat Pump, Trane. Equipment using R-22 refrigerant will not be considered (R-410a is preferred). Equipment shall be provided with two (2) year parts and labor warranty; additional three (3)-year compressor warranty. All units (ducted or console) shall be controlled by space mounted temperature sensors and DDC microprocessors furnished by ATC/EMS.
- 2. Submittal requirements
  - a. Unit sound power data rated in accordance with ARI 260 shall be included in submittal.
  - b. Heat Pump manufacturers must coordinate control requirements with ATC/EMS prior to submission of equipment shop drawings and shall include statements confirming controls coordination in the manufacturers' submittals.
- 3. Fan motors shall be 3-speed high efficiency PSC, wired on high-speed tap; internal thermal overload protection.
- 4. Manufacturer furnished phase monitor and condensate pan drain monitor shall be provided for all units.
- 5. Control valves for the heat pumps are to be furnished by ATC/EMS for field installation; valves are not to be furnished by the heat pump manufacturer.
- 6. Hose kits shall be thermoplastic rubber, 2-3 feet long, braided galvanized steel. The hoses shall be male pipe thread on both ends with a separable female adapter fitting, for one end. The adapter fitting shall include a pressure, temperature port (P/T) access fitting to permit temperature or pressure measurements. The thermoplastic rubber materials shall have UL-94, V-O rating. Hoses shall be fire retardant and smoke rated.

##### **B. Ducted Units (Vertical and/or Horizontal):**

- 1. Filter racks are to be field fabricated; racks shall be hinged, gasketed and latched to accommodate the filter. Filters shall be 2" thick pleated with an ASHRAE MERV 8 rating.
- 2. Sound reduction package shall include vibration isolation to the compressor and water-to-refrigerant coil, a second stage of vibration isolation to the compressor base pan, heavy gauge base assembly, insulated metal compressor enclosure, and maximum sized return-air opening and filter sizing.
- 3. Submittals special requirements: Filter racks and heat pump shop drawings shall be submitted together.

##### **C. Console:**

- 1. Manufacturers' standard height, flat top casing; sound attenuation package, access panels for internal components.

2. Disposable pleated 1" filters.

## 2.2 Dedicated Outdoor Air Systems (DOAS) / Energy Recovery Units (ERU)

### A. General:

1. Outdoor or indoor mounted air handling units utilizing one or two cross-flow flat-plate heat exchangers, and geothermal or conventional water source heat pumps (HFC 410A refrigerant) as applications dictate. Approved manufacturers are Des Champs, Engineered Air, Innovent, Xetex. Casings shall be 2" insulated double wall. All units shall be furnished with single point connections for both piping and electric. Manifold headers, head pressure control valves, balancing valves, etc shall be internal to the unit and factory furnished. Equipment shall be provided with two (2) year parts and labor warranty; additional three (3)-year compressor warranty.
2. Unit disconnect shall be field installed (Div 16) and mounted external to the unit casing.
3. Fans
  - a. Supply Fan: Constant volume direct drive plug type with VFD for balancing
  - b. Exhaust Fan: Direct drive plug type with VFD; fan may operate as constant volume or may be variable volume when accommodating variable exhaust quantities associated with High School science wings or demand ventilation (CO<sub>2</sub>) control sequences.
  - c. Motors: 3 phase TEFC, NEMA frame, 1.15 service factor.
  - d. VFDs shall be factory furnished and mounted on exterior of unit casings; internal mounting in fan sections is unacceptable.
4. Refrigeration: Integral water-cooled reverse cycle heat pump system, direct expansion coil, scroll compressors, reversing valve, minimum of 2 totally independent refrigeration circuits, head pressure controlled heat pump water valves (2-way or 3-way as accommodating system minimum flow rates may dictate).
5. Filters: 2" MERV 8 at outdoor intake and ahead of return/exhaust air entering heat exchanger.
6. Access: Access doors and access space shall be provided on both sides of units mounted indoors.
7. Lights: Units shall be provided with weatherproof marine lights inside of sections on a common electrical circuit controlled by 30-minute timer switch.
8. Power Circuits: Single point power connection for unit power. Water side heat exchanger section electric heater (roof mounted equipment) shall be on emergency power. Internal lights shall be on a separate circuit; placing lights on electric heater emergency power circuit is acceptable.
9. Roof Mounted
  - a. Casing shall be factory painted galvanized G90; unpainted casings are unacceptable.
  - b. Insulated, 16" high curbs.
  - c. Security grilles secured with tamper proof screws shall be provided at supply and return air outlets.
  - d. Manufacturer's service vestibules on units greater than 6' tall. Vestibule shall be provided with lights on timer switch and thermostatically controlled exhaust fan and electric heater.
  - e. Water side heat exchanger section provided with electric heater on emergency power.
  - f. Weather hoods and birdscreen for exposed intake and exhaust.
10. Controls:
  - a. Manufacturer furnished controls for refrigerant cycle, refrigerant safeties, freezestats; EMS furnished controls for temperature control, energy management routines (Gas heat units shall be provided with factory furnished controls). EMS contractor is to furnish EMS

controls to DOAS/ERU manufacturers for factory installation. EMS furnished controls include damper actuators; temperature, humidity, CO<sub>2</sub> sensors; DDC microprocessor.

- b. Manufacturer's controller and EMS microprocessor are to be installed in enclosure on exterior of DOAS/ERU casing; weatherproof enclosure on units located outdoors. Both controllers to have displays and keypads.

B. Dedication Outdoor Air Ventilation Systems (DOAS); discharge air control:

1. Components:

a. Two Heat Exchangers:

- 1) Outdoor / exhaust air heat exchanger (Heat Exchanger #1)
- 2) Tempered outdoor air / conditioned supply air (Heat Exchanger #2)

b. Dampers and Actuators:

- 1) Motor operated outdoor air intake face and by-pass opposed blade dampers with separate actuators, both dampers normally closed, modulating control.
- 2) Motor operated exhaust parallel blade damper.

2. Function: Unit shall operate as follows via EMS programming:

- a. Unit shall run continuously during occupied mode and be off during unoccupied mode unless otherwise energized due to high space humidity levels (60% RH, adjustable).
- b. When the unit is started, the outside air damper (heat exchanger face damper) and exhaust air damper open; when the dampers are fully open, the supply and exhaust fans start. The heat exchanger by-pass damper is closed.
- c. Cooling: Cooling shall be disabled at outdoor air temperatures below 55°F. Heat pump cooling/dehumidification output shall be controlled to maintain the greater demand of 72°F supply air temperature or 55°F supply air dewpoint; compressors shall cycle and step subject to 50°F DX coil leaving air low limit and/or supply air 60°F low limit.
- d. Heating: Heating shall be disabled at outdoor air temperatures above 70°F. At outdoor air temperatures below 70°F, reversing valve shall be positioned for heat and compressors shall cycle and step to maintain 70°F supply air temperature. Supply air dehumidification cycle shall override heating cycle to prevent supply air dewpoint from exceeding 55°F.
- e. Outside Air HX-1 face and by-pass dampers: Both dampers shall be closed when the unit is off. When the unit is running, the face damper shall normally be open to the heat exchanger.
  - 1) Winter Defrost Mode: The face / by-pass dampers modulate to prevent the exhaust air temperature from dropping below 33°F.
  - 2) Economizer Mode: Economizer operation is disabled when outdoor air enthalpy is above 26 BTU/lb or when outdoor air temperature is below 50°F. When economizer is enabled and outside air temperature is below supply air cooling setpoint, the outside air face and by-pass dampers at HX-1 shall modulate open to by-pass the heat exchanger to maintain supply air temperature set-point.
- f. Condenser water valves, distinct from the DOAS manufacturer furnished head pressure controlled condenser water valves, shall cycle open and close with the compressors when outdoor air temperatures are above 40°F; valves shall be open to condensers at outdoor air temperatures below 40°F. Flow switch in the water supply shall disable the compressors in the event of no water flow while the valve is commanded open; the DOAS fans shall continue to operate, unless disabled by the low discharge temperature limit.
- g. Compressors shall be staged and cycled to maintain controlling temperature with appropriate deadbands and timing intervals to prevent short cycling; manufacturer's refrigerant system safeties override EMS operations. Compressors shall be disabled when supply fan shows off status.

- h. Reversing valve shall position appropriate to heating/cooling duty.
  - i. Freezestats: Supply air freezestat to de-energize the unit if the supply air leaving the unit drops to below 40°F. DX coil freezestat shall de-energize the unit if the supply air leaving the DX coil drops below 45°F.
  - j. Condenser Compartment Electric Heater (outdoor units): Heater shall be enabled whenever outside air temperatures drop to 40°F and shall cycle to maintain compartment temperature setpoint. An alarm shall enunciate in the BAS if compartment temperatures drop below 35°F.
- C. DOAS/ERU Modifications: In some applications, DOAS & ERUs may be furnished as air cooled direct expansion cooling and gas fired furnace heating. Design and operations shall be similar to above. Furnaces shall have modulating control, stainless steel heat exchanger with 10-year warranty. Manufacturer furnished controls with BACnet interface for EMS start/stop functions.

## 2.3 Modular Air Handling Units:

### A. General:

1. Outdoor or indoor mounted air handling units 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. Casings shall be 2" insulated double wall.
2. Double wall construction access panels 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; access panels and doors shall be fully removable without the use of specialized tools. All doors shall have gasketing around full perimeter to prevent air leakage.
3. Fans shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2" isolators. Flexible canvas ducts shall be installed between fan and unit casing to ensure complete isolation.
4. 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; zerk fittings.
5. Supply and return header connections shall be clearly labeled on outside of units.
6. Drain Pans: Comply with ASHRAE 62.1.
  - a. Units with cooling coils shall have stainless steel 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 1/8" per foot toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's requirements. On stacked cooling coils, intermediate drain pans shall be installed between the coils with drop tubes to guide condensate to the main drain pan.
  - b. Units with heating coils shall have a stainless steel drain pan under complete heating coil section sloped in 2 planes and pitched toward drain connections to ensure proper drainage during cleaning and to capture water in the event of a coil failure.
7. All dampers shall be internally mounted. Dampers shall be premium ultra low leak 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 inches water gauge.
8. Filters: MERV 8.
9. Approved manufacturers of air handling units are Trane, McQuay, Carrier, Aeon, York.
10. Units shall be controlled by DDC microprocessors furnished by ATC/EMS.

## 2.4 Packaged Rooftop Equipment

A. General:

1. Components are factory designed and assembled and include outdoor-air and return-air dampers, fans, filters, heating/cooling coil, compressor, controls, and water-cooled condenser. The heating source is provided by either an indirect-fired gas burner, electric resistance heat, or by reversing the refrigeration circuit to operate the unit as a heat pump. Heat pump units may use an auxiliary heat source (typically electric resistance heat) during the defrost cycle.
2. Unit must have double wall cabinet construction with interior insulation and corrosion resistant coils
3. Fans and compressors shall be internally isolated.
4. Drain Pans: Comply with ASHRAE 62.1.
  - a. Units with cooling coils shall have stainless steel 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 1/8" per foot toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's requirements. On stacked cooling coils, intermediate drain pans shall be installed between the coils with drop tubes to guide condensate to the main drain pan.
5. Filters: MERV 8.
6. Approved manufacturers of air handling units are Trane, McQuay, Carrier, Aeon, York.
7. Units shall be controlled by DDC microprocessors furnished by manufacturer.
8. Unit Function:
  - a. During unoccupied mode, unit shall be off unless operations are required for warm-up/cool-down, night set-back, extended leave high space humidity levels. When the unit is off, fans shall be off, outdoor air damper closed, recirculation damper open. When operating in the unoccupied mode; outdoor and exhaust air dampers remain closed, recirculation damper remains open, exhaust fan remains off. In night set-back, supply fan and compressors shall cycle in heating to maintain space night set-back temperature setpoint. In warm-up/cool-down supply fan runs continuously with compressors running in the appropriate mode.
  - b. When commanded to the occupied mode, the exhaust damper opens, exhaust fan starts and ramps to its minimum speed; the supply fan starts. Outdoor air damper opens to its minimum outdoor air position; recirculation damper tracks outdoor air damper.
  - c. Energy Recovery (If Utilized): Damper is normally open to the heat exchanger, closed to by-pass.
    - 1) Winter Defrost Mode: The by-pass shall modulate to prevent the exhaust air temperature from dropping below 33°F.
    - 2) Economizer Mode: When outside air enthalpy is below 26 BTU/lb and less than return air enthalpy, the unit control shall modulate to by-pass the heat exchanger to maintain the space temperature cooling set-point.
  - d. Compressors cycling and reversing valve operations shall maintain space cooling and heating temperature setpoints. Supply air discharge shall have a 55°F low limit; the air leaving the DX coil shall have a 45°F low limit. Compressors shall be staged and cycled with appropriate deadbands and timing intervals to prevent short cycling; manufacturer's refrigerant system safeties control the unit.
  - e. The space relative humidity shall not exceed its setpoint (60% RH, adjustable), the cooling refrigeration system shall operate to maintain 55°F DB from the DX coil.
  - f. Exhaust air fan shall maintain space differential static pressure sensor setpoint. (Integral or separate)
  - g. Condenser water valve shall cycle open and closed with the compressor when outdoor air temperatures are above 40°F; valve shall be open at outdoor air temperatures below

40°F. Flow switch in the water supply shall disable the compressors in the event of no water flow while the valve is commanded open; the RTU fans shall continue to operate, unless disabled by the low discharge temperature limit.

- h. Freezestat shall de-energize the unit, 40°F setpoint.
- i. Condenser Compartment Unit Heater (outdoor units): Heater shall be enabled whenever outside air temperatures drop to 40°F and shall cycle to maintain compartment temperature setpoint. An alarm shall enunciate in the EMS if compartment temperatures drop below 35°F.

## 2.5 Ventilation Strategies

### A. General:

- 1. One or all of the following ventilation strategies shall be utilized for zones not served by a DOAS.
- 2. An energy and IAQ evaluation shall be performed prior to selecting a ventilation strategy.

### B. Demand Control Ventilation:

- 1. CO<sub>2</sub>-based demand control ventilation (DCV) for single-zone systems shall implement proportional control or single setpoint strategies based on the type of zone occupancy. Refer to ASHRAE Standard 62.1 user's manual for additional information.
  - a. Proportional control requires a modulating outdoor-air damper, and a controller with two CO<sub>2</sub> limits ( $C_{s-design}$ ,  $C_{s-min}$ ) and two OA damper limits that correspond to intake airflows ( $V_{ot-design}$ ,  $V_{ot-min}$ ). This strategy should be utilized in zones where partial occupancy is not the norm.
  - b. Single setpoint control requires a modulating outdoor air damper, and a controller with one CO<sub>2</sub> limit ( $C_{s-min}$ ) and one OA damper limit that correspond to intake airflow ( $V_{ot-min}$ ). This strategy should be utilized in zones where partial occupancy occurs frequently to avoid over-ventilation. A minimum occupancy ( $P_{z-min}$ ) shall be selected based on the zone type and communicated to MCPS.
- 2. Control strategies shall take into account localized exhaust to prevent negative building pressure.
- 3. Designer must account for part-load humidity control. Hot gas reheat is recommended for DX unitary equipment.
- 4. Sensors
  - a. Unit Mounted: Air temperature entering refrigerant coil, air temperature leaving refrigerant coil, supply air temperature to building, return air temperature, leaving air humidity/dewpoint.
  - b. Field Mounted: Space temperature, space pressure, space humidity/dewpoint, and space CO<sub>2</sub>.
- 5. Unit Function: Unit shall operate as follows via EMS programming:
  - a. If space CO<sub>2</sub> exceeds its setpoint (adjustable) OA damper position shall modulate based on DCV strategy, the outside air damper shall modulate towards the open position with the recirculation damper tracking toward closed.

### C. Air-to-Air Energy Recovery:

- 1. Sufficient economical evaluations must be performed to justify the use of energy recovery.
- 2. Allowable devices include fixed plate. Exhaust Air Transfer Ratio (EATR) shall not exceed requirements of ASHRAE Standard 62.1 for designed exhaust air classification.
- 3. Where an air-side economizer is utilized in conjunction with an energy recovery device, provide a by-pass strategy to reduce air-side pressure drop and also avoid adding heat to the outdoor airstream. When an air-side economizer is not utilized provide control to prevent the

transfer of unwanted heat during mild outdoor conditions. When operating during winter conditions provide means of frost protection.

4. Sensors

- a. Unit Mounted: Air temperature leaving recovery device, air temperature entering refrigerant coil, air temperature leaving refrigerant coil, supply air temperature to building, return/exhaust air temperature; exhaust air temperature leaving the recovery device.
- b. Field Mounted: Space temperature, space pressure, space humidity/dewpoint.

5. Unit Function: Unit shall operate as follows via EMS programming:

- a. HX Face & By-pass dampers: Damper is normally open to the heat exchanger, closed to by-pass.
  - 1) Winter Defrost Mode: The face / by-pass dampers shall modulate to prevent the exhaust air temperature from dropping below 33°F.
  - 2) Economizer Mode: When outside air enthalpy is below 26 BTU/lb and less than return air enthalpy, the face and by-pass dampers shall modulate to by-pass the heat exchanger to maintain the space temperature cooling set-point.

2.6 Gas Fired Make-Up Air Units, Heating & Ventilating Units

- A. General: Modulating burner control, stainless steel heat exchanger with 10-year warranty.
- B. Make-Up Air Units (normally associated with kitchen hoods): 100% outdoor air, 2-position motorized outdoor air damper, discharge air temperature control (68-70°F setpoint), manufacturer's controls.
- C. Heating & Ventilating Units (Gyms, Locker Rooms): Space temperature control; controls by EMS. Return air and outdoor air dampers.
- D. Filters: MERV 8.

2.7 Cooling Tower: Open towers with indoor heat exchangers.

A. Cooling Towers:

1. Evapco "Low Sound" AT series towers preferred, particularly in noise sensitive areas. BAC 1500/3000 series and similar of Marley are acceptable where tower sound is not an issue for facility occupants or neighbors.
2. Towers shall be up draft with propeller fan, variable frequency fan drive; VFD mounted at tower. Fan-motor drive assemblies with band belts, greaseable bearings with lubrication lines extending to casing exterior, 5 year motor and drive warranty
3. Factory assembled, hot-dip galvanized construction (G235 or G210 with polymer coating), sectional counter-flow blow-thru design with propeller fan assemblies, combination pan-fan sections, heat transfer sections, spray tree, vibration isolator mounts, eliminators and discharge louver.
4. Full size stainless steel basin, bottom drain, access doors, large area lift-out stainless steel strainer with perforated openings sized smaller than spray nozzle orifices, waste water bleed line with valve, electric float switch and solenoid make-up valve.
5. Factory furnished ladder and service platform complying with OSHA standards for top access; factory furnished davit.
6. Electric water level control for make-up water. Electric sump heater for winterization. Vibration shut-off switch.
7. Factory furnished controls shall be provided for water level, sump heater, vibration shut-off; EMS will control fan speed.

B. Heat Exchangers: Plate and frame; type 304 stainless steel plates.

2.8 Boilers – Gas Fired Condensing:

- A. Gas-fired condensing type package boilers, factory-fabricated, assembled, and tested with trim and accessories for generating hot water, 60 psig maximum design pressure rating. Heat exchanger sealed pressure-tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections, and controls. Boilers shall have minimum efficiency according to ASHRAE/IESNA 90.1 Table 10-8.
- B. Pulse-Combustion: Approved manufacturers are Fulton Boiler Works, Inc.; Hydrotherm, Inc.; carbon-steel intake muffler and stainless-steel exhaust; cast-iron condensate trap body with stainless-steel internal parts. Heat Exchanger Warranty: 10-year for thermal shock damage, 5-year for corrosion.
- C. Water-Jacketed Condensing: Approved manufacturer is Viessmann Mfg. Co. (US) Inc., inlet and vent combustion air duct collars. 8-year material and leakage warranty; 5-year heat exchanger warranty for corrosion and thermal stress damage.
- D. Gas train with combination gas valve with manual shutoff and pressure regulator. Boilers with electric-spark ignition with 100 percent main-valve shutoff and electronic flame supervision.
- E. Boiler Controls: Burner safety controls limit the operation of burner; manual reset high pressure/temperature cutoff; manual reset low water cut-off; manual reset combustion air inlet safety switch; visual and audible alarm.
- F. Boiler System Controls: Boiler manufacturer furnished multi-boiler controller to stage boilers per manufacturer's recommendations for optimum efficiency. Controller to be enabled/disabled by hard-wire connection from EMS and provide a boiler alarm output to be monitored by EMS hardwire (not BACnet, LonWorks, ModBus, etc.) Boilers' firing shall be such to maintain condenser water loop temperature (normally a 70°F setpoint); condenser loop temperature sensor shall be by boiler manufacturer.
- G. Combustion Air and Venting: Boiler manufacturer combustion air and vent kits or Type B vents.

## 2.9 Chillers

- A. Elementary schools shall be air-cooled and middle and high school units shall be water cooled. Air-cooled machines shall be provided with split evaporator section and control panel located in mechanical room. Special attention must be given to sound levels when selecting compressors and basis of design units. Refrigeration safeties must comply with state and local codes. Units shall be provided with factory furnished controls that are enabled/disabled by EMS. Chiller controls shall operation condenser water pumps if required.
- B. Approved manufacturers are Johnson Controls (York), McQuay, Trane.

## 2.10 Pumps

- A. General:
  - 1. Approved manufacturers of base-mounted and in-line pumps are Bell and Gossett, Taco, Armstrong, Aurora.
  - 2. All pumps with motors one HP and larger must be base mounted.
- B. Base Mounted: Vertical split case, centrifugal, end suction design, bronze fitted, grease lubricated ball bearings, non-overloading motor. Volute casing shall be directly supported by the pump base. C-Channel mounting bracket shall attach the pump to the base for ease of maintenance.
- C. In-Line: Centrifugal, radially split case, cast iron casing, bronze fitted, mechanical seals, replaceable bearings, motor resiliently mounted to casing.
- D. Accessories:
  - 1. All pumps:
    - a. Suction and discharge pressure gauges
    - b. Stainless steel strainers
    - c. Check, balancing, and shut-off valves; triple duty valves are acceptable but separate shut-off valve also required.



2. Base Mounted:

- a. Provide with suction diffusers; support foot, drain, stainless steel diffuser/strainer.
- b. Flanged, stainless-steel braided flexible piping connections; rubber type prohibited.

2.11 Motors

- A. Motors smaller than 1/2 HP shall be single phase; permanent split capacitor or split-phase type. Motors 1/20 HP and smaller shall be shaded-pole.
- B. Motor 1/2 HP and larger shall be 3-phase; NEMA MG1 design B with class B or F insulation; except all motors used in conjunction with variable frequency drive controllers shall be NEMA class F insulation. Nominal full load efficiencies shall meet or exceed NEMA MG1 Premium ratings.
- C. Motors shall be open drip-proof (ODP), except motors located in boiler rooms or designated mechanical rooms shall be totally enclosed fan cooled (TEFC). Motors located outdoors shall be totally enclosed air-over (TEAO), reversible, squirrel cage.
- D. Multi-speed motors shall be separate winding for each speed.

2.12 Variable Frequency Drives (VFDs)

- A. All variable frequency drives furnished on the project shall be of the same manufacturer, whether furnished as a separate piece of equipment or provided as a component of manufactured equipment (air handlers, package pump system, energy recovery unit, etc); and shall meet the following requirements.
- B. Acceptable manufacturers: ABB Power Distribution, Trane/Danfoss, Yaskawa.
- C. Drives shall have pulse width modulated (PWM) inverter and diode-bridge rectifier and equipped with:
  - 1. Keypads for user interface; displays for frequencies, motor current, volts, speed.
  - 2. Capability of receiving 2-10V or 4-20mA external speed control signal
  - 3. Power input breaker to provide manual disconnect, located inside of panel door with handle on door exterior with on-off-tripped handle indicator.
  - 4. Manual by-pass
  - 5. Phase, voltage, frequency protection
  - 6. Automatic reset and restart.
  - 7. H-O-A switch or keypad.
  - 8. Ventilation fan with washable intake filter.
- D. Drives shall be equipped to interface with the EMS via hardwire (not BACnet, LonWorks, etc.), receiving remote start/stop and speed commands and providing a drive failure alarm.

2.13 Electric Heat: Acceptable manufacturers are Trane Company, Markel, Q-Mark, Brasch, Berko. Heaters shall have a 10-year element limited warranty.

- A. Duct coil: Built-in pressure type airflow switch; auto-reset primary thermal cutout with manual reset in series with auto-reset; manual reset button shall be accessible without opening terminal box. Heaters over 5 KW shall be multiple step; multiple step shall have delay relay to prevent all steps from coming on at one time. Heaters' space temperature control shall be by EMS.
- B. Cabinet Heater: Blow thru with direct drive 2-speed fan in air stream, supply and return air grilles in casing cover, thermal protection, auto reset overheat switch, throw away filters. Wall mounted electric thermostats furnished and installed by EMS.
- C. Unit Heater: Ceiling suspended, thermal overload protection, manufacturer's hanging bracket and space mounted thermostat.
- D. Wall Heater: Surface or recessed mounted; thermal overload protection, integral tamper resistant thermostat.

- E. Baseboard: Wall mounted enclosures with end caps, blank sections, debris screen at discharge; integral tamper resistant thermostat, auto-reset thermal overload protection.
- 2.14 Water Treatment: Complete water treatment systems shall be furnished by contractor; include a two (2) year maintenance period with bimonthly site visits; components shall be as follows:
  - A. Lakewood Conductivity Controller 2175-RTC with 25' cable.
  - B. Turbine Water Meter operation
  - C. System Filter: Harmsco #HIF-7-SS housing; 801-20HT filter
  - D. Tanks
    - 1. Inhibitor Tank: Medium density polyethylene tapered calibrated tank with cuff type flange and cover; 45 gallons.
    - 2. Biocide Tanks: Two (2) heavy wall medium density polyethylene storage tanks & cover; 5 gallons each.
- 2.15 Exhaust Fans: Accepted manufacturer Penn Barry, Greenheck, Cook
  - A. Power Roof Ventilators
    - 1. 12" curbs by fan manufacturer
    - 2. Backdraft dampers shall be furnished as a component of the fan by the manufacturer; gravity or motor operated. No dampers on kitchen fume hood fans. Avoid use of ATC furnished dampers.
  - B. Ceiling: Direct drive motor isolated by rubber mountings, squirrel cage impellers, acoustic lining, duct outlet, access panels for service, backdraft damper and ceiling grille.
- 2.16 Split System Air Conditioning Units: Factory furnished controls, low-ambient operation to 0°F for air cooled units, manufacturer furnished controls.
  - A. Ductless & Ducted split systems: Air cooled utilizing R-410A refrigerant.
  - B. Variable Refrigerant Flow: Acceptable products are Mitsubishi City-Multi and Daikin VRV; water cooled.
- 2.17 Variable Air Volume Terminals: Pressure independent; accepted manufacturers: Titus, Krueger, and Trane. Extended air valve actuator shaft for mounting of actuator external to unit. Terminals can be throttling only with or without heating (hot water or electric) or series fan powered with heating coil. Terminals to have direct digital controls, including heating coil control valves with electric actuators, furnished by EMS, field or factory installed.

### **PART 3 – EXECUTION**

- 3.1 General:
  - A. Provide service access to all equipment. Show access areas on contract drawings.
  - B. Spare Parts: Require
    - 1. Fan belts: one for each belt driven fan. Spare belts shall be labeled with equipment name/number and be wall hung on peg board in main pump room. Provide wall space in room design for spare belt pegboard.
    - 2. Filters: eight spare sets for each unit (in addition to initially installed filters).
    - 3. Equipment list with filter sizes and belts identified.
  - C. Every factory trained technician involved in equipment start-ups shall have had a minimum of 40 hours factory training on the equipment and provide a certificate or other information verifying that this training has taken place within the last 24 months.
- 3.2 Water Source Heat Pumps
  - A. General:
    - 1. Piping: Each heat pump will have the following piping installation:

- a. Supply Side: Ball valve with pressure/temperature port; two or three foot hose with MPT adapter; strainer with plug blow down and pipe reducer fitting.
      - b. Return Side: Ball valve with pressure/temperature port and memory stop; automatic balancing device with two pressure ports; ATC furnished condenser water valve, two or three foot hose with MPT adapter and pipe reducer fitting.
      - c. Supply and return piping shall be hard-pipe cross connected with shut off valve ahead of heat pump shut off valves to allow circulation of water through the entire pipe loop for thorough flushing of the water system. Entire water loop system shall be flushed until free of dirt, weld slag and other debris to the Engineer's satisfaction before allowing flow to heat pump. Cross over pipe shut-off valve shall be left closed and handle removed after flushing.
      - d. Drain pans shall be provided with float switches to shut down units. Run condensate drain in piping to floor drain.
    2. Piping branches providing runouts to more than 2 heat pumps shall be furnished with shut-off valves.
    3. Mock-ups: Mock-ups for complete installation of each type of heat pump are required for approval by MCPS. Mock-ups shall be provided for a console, a single closet mounted heat pump, and for two heat pumps in a common closet.
  - B. Vertical Ducted: Units shall be located in mechanical closets; closets shall be of suitable size to allow complete servicing of equipment. For classroom applications, generally closets shall accommodate two heat pumps serving two adjacent classrooms.
    1. Heat pumps shall be mounted on black-steel channel structure, nominally 30" above floor. Heat pump shall sit on vibration pads on the steel channels.
    2. Supply air ductwork shall be connected to heat pump with flexible connection.
    3. Custom filter rack shall provide access and filter removal from the side of the assembly.
    4. Return air shall be ducted, flexible connection provided at heat pump.
    5. Include location of disconnects and wall mounted EMS controller enclosures on contract drawings.
  - C. Horizontal Ducted: Similar to vertical units; hung with vibration isolators.
  - D. Console:
    1. Condenser water control valves shall be located in ceiling cavities above or below the equipment with hand valves to service control valves. Ceiling tags shall be provided indicating valve locations.
    2. ATC furnished condenser water control valves may be omitted to assist in accommodating condenser water system minimum flow.
  - E. Controllers: ATC furnished microprocessors shall be wall mounted in enclosures in equipment closets for vertical ducted units. Horizontal ducted controllers shall be mounted in enclosures in ceiling cavities. Console unit controllers may be located within the heat pump console or remotely mounted in enclosures in ceiling cavities. Amplification of controls requirements/installation is in the HVAC Controls Systems section of this Guide.
- 3.3 Dedicated Outdoor Air Systems (DOAS) and Energy Recovery Units (ERUs)
- A. Outdoor: Factory furnished roof curbs; curbs may be filled with 6" light weight concrete for sound abatement.
  - B. Controls Coordination: Manufacturer to install ATC furnished controls; ATC to provide software loaded controllers to manufacturer for factory start-up and testing. On-site start-up and operations verification to be performed by DOAS/ERU manufacturer authorized technician and EMS contractor.
  - C. On-site start-up shall be performed with factory personnel. Service trained contractor technicians are not acceptable for the initial start-up. Start-up shall not take place until proper condenser

water flows to the DOAS/ERUs have been verified; water balancing report shall be provided to the DOAS/ERU manufacturer and the A/E certifying that the units are receiving the scheduled water flows.

3.4 Air Handling Units:

- A. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- B. Provide solar powered digital display thermometers in outdoor, return, and supply air ductwork within mechanical room.

3.5 Cooling Tower, Heat Exchangers

A. Cooling Tower:

- 1. Make up water solenoid valve to be installed inside mechanical room with strainer and manual by-pass.
- 2. Provide drain to sanitary sewer line.
- 3. VFD shall be mounted at tower.
- 4. Tower fan shall be hardwire interlocked with condenser water pumps' status (fan cannot run without pump running).

B. Heat Exchangers:

- 1. Valves, fittings to heat exchanger shall be arranged to allow disconnecting heat exchanger from piping for cleaning/service by only having to unbolt piping flanges at heat exchanger. Provide by-pass valves in condenser water and cooling tower piping to allow servicing of heat exchanger.
- 2. Provide pressure gauges and solar digital thermometers for both sides entering and leaving water.
- 3. Require complete set of spare gaskets (flanges and plates).

3.6 Boilers – Gas Fired Condensing

- A. Set on concrete housekeeping pad; provide vibration isolation per boiler manufacturer's recommendations.
- B. Provide pressure setting for safety relief valves.
- C. Assure that floor drains are provided in boiler areas so that relief and condensate piping are not tripping hazards. Provide condensate dilution per boiler manufacturer's recommendations.
- D. Piping connections to boilers, except safety relief valve connections, are to be flexible connectors of materials suitable for service. Connect hot-water supply and return piping to boiler tappings with shutoff valve and union or flange at each connection.
- E. Connect gas piping full size to boiler gas-train inlet with union.
- F. Factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service; including set-up of multi-boiler controller.
- G. Provide solar digital thermometers in common heating water supply and return piping.
- H. Boiler permit and State inspection are contractor's responsibility.

3.7 Pumps

A. Base Mounted:

- 1. Set on concrete housekeeping pads; pump bases shall be bolted to concrete pads. Pump bases shall be filled with concrete after mounting.

2. Pumps bases shall be provided with vibration pads where housekeeping pads are located on slabs-on-grade. Inertia bases shall be employed for pumps over 20 HP where located on slabs above grade.
3. Pumps shall be aligned by manufacturer's authorized technician.
- B. In-Line: Pumps shall be supported independent from piping.
- C. Provide pressure gauges for suction and discharge.
- D. Pumps for geothermal systems shall insulated with removable covers; covers shall be constructed of 18 gauge galvanized steel formed with edge returns so insulation is not damaged in cover removal or replacement; access panels shall be latched so complete removal/replacement occurs without use of tools.

### 3.8 VFDs

- A. Start-up shall be by manufacturer's authorized technician.
- B. Drive minimum speed setting (normally 12 Hz) shall be per manufacturer's recommendations. Acceleration and deceleration rates shall be programmed and documented.
- C. Where VFDs are provided, each motor shall be provided with a dedicated VFD; one VFD controlling multiple motors is not acceptable.
- D. Require labels to be affixed to VFDs citing location and identity of controlling sensor(s); duct static or piping pressure. Controlling sensors shall also be identified and labeled in building; ceiling concealed sensors shall have ceiling tags installed citing sensor identification.
- E. Spare Parts:
  1. Require spare washable intake filter for each drive.
  2. Require spare fuses for each drive to be furnished and stored in a wall box adjacent to each drive.

### 3.9 Water Treatment

- A. A 3/4" by-pass tee with ball valve shall be provided at water source condensers to allow flushing of piping systems without passing thru the condensers.
- B. Complete water treatment systems are to be provided for closed condenser water system and open cooling tower water system. Provide all taps and valves; pipe and fittings shall be Schedule 80 PVC. Provide domestic cold water outlet and hose fitting next to water treatment equipment and tanks.
- C. Cleaning:
  1. Open loop systems shall be cleaned as follows:
    - a. Use a cooling tower cleaner as directed by the manufacturer.
    - b. Flush the system with fresh water. Drain the flush water and fill again with water.
    - c. MCPS mechanical specialist shall inspect the system.
    - d. Add inhibitor.
  2. Closed loop systems shall be cleaned as follows:
    - a. Allow cleaning solution to circulate through the system for 24-72 hours, during which time the system shall reach operating temperature.
    - b. Flush with fresh water and refill with fresh water and purge air.
    - c. MCPS mechanical specialist shall inspect the system.
    - d. Contractor shall provide and install new water filters in housing and run system pumps for 72 hours to clean system. New filters shall be installed after the 72 hours and removed filters shall be inspected by MCPS mechanical specialist.

- 3. Contractor shall coordinate with MCPS mechanical inspector to verify that the cleaning and flushing has been done. The Contractor must have MCPS approval of the cleaning and flushing in writing.
  - D. Water Treatment: Contractor shall maintain water treatment systems through the duration of the warranty period.
  - E. Spare Filters: Contractor shall provide 2 cases of filters to MCPS for their use upon the end of the warranty period.
- 3.10 Split System Air Conditioning Units
- A. Air cooled condensing units shall be roof mounted, elevated above roof on stainless steel covered 2'x12" wood supports.
  - B. Refrigerant and condensate piping shall be shown on contract drawing floor pans.
- 3.12 Well Fields Piping:
- A. Provide temperature/pressure (e.g. Pete's Plug) in supply and return piping at each well header.
  - B. Provide full size manual by-pass in pump room.

**END OF SECTION**