TABLE OF CONTENTS

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section specifies the basic requirements for mechanical (HVAC, Plumbing and Fire Protection) installations and includes requirements common to more than one section of Division 15. It expands and supplements the requirements specified in sections of Division 1.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 ACCESSIBILITY: Install equipment and materials to provide required access for servicing and maintenance minimum of 3 feet clearance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. Extend all grease fittings to an accessible location.

1.03 MECHANICAL INSTALLATIONS

A. Coordinate mechanical equipment and materials installation with other building components. Verify all dimensions by field measurements. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
   1. All floor mounted equipment (and equipment on grade) shall be installed on a minimum 4” tall concrete pad. Provide I-beams or additional concrete pad height where the condensate trap requirements require more height. Pads outdoors shall be provided with a security fence.
   2. The concrete pad shall have no contact with any metal portion of the equipment or that equipment’s support. Provide ¼” thick red, or black, rubber pad under the entire metal surface intended to rest on the concrete pad.
   3. All HVAC equipment (except small fans) shall be floor mounted; not above the ceiling. The CONTRACTOR shall obtain written approval from the PROJECT COORDINATOR for any exceptions.
   4. All interior chilled water pipe above ground shall be schedule 40 black steel (2-1/2” and larger) OR Schedule L copper (2” and smaller), insulated and jacketed. Jacketing for interior piping shall be all service jacket (ASJ) and two coats painted with rust inhibiting paint in exposed areas: dark blue for supply and light blue for return. Exterior chilled water piping shall be schedule 40 black steel, insulated and covered with 0.016 thick, smooth finish, aluminum jacket with factory applied integral moisture barrier. Underground chilled water piping shall be factory pre-insulated, with schedule 40 black steel carrier and a high density polyethylene (HDPE) jacket.

5. All mechanical equipment and devices shall be located in accessible locations, preferably for access without a ladder. Where installations above ceilings or behind walls are strictly necessary, ceiling and wall access panels of minimum 24" x 24" shall be provided at all equipment and/or devices that require access and maintenance.
6. Dielectric unions/ protection shall be provided at all points of connection between dissimilar metals; pipe, hangers, connections to structural steel, etc.
7. The installing CONTRACTOR shall be responsible for furnishing and replacing all air conditioning filters during the construction phase up to the Substantial Completion of the project. From that time on, the District will retain all responsibility.
8. The installing CONTRACTOR shall be responsible for all air conditioning equipment fan belts up to the end of the warranty period. From that time on, the District will retain all responsibility.
9. When using small, air cooled mini-split systems (manager's office, dry storage, electrical room, etc.), the location of the condensing unit is to be outside, mounted on a concrete pad.
10. Equipment that requires access for maintenance and service (VAV Boxes, fans, dampers, etc.) and that are located above ceilings shall be placed below the bottom chord of trusses or joists, unless the PROJECT COORDINATOR grants a special exception in writing. Manufacturer and code required clearances shall be maintained around and in front of the equipment.
11. All new air-conditioning systems shall be ducted. Return air plenums will only be allowed in existing installations and only when approved in writing by the PROJECT COORDINATOR.
12. Mechanical rooms shall not be used as return air plenums. A minimum of 36" minimum clearance all around air handlers, including non-access sides shall be provided. Where existing conditions prohibits achieving the 36" clearance, coordinate with PROJECT COORDINATOR for a waiver.
13. All mechanical rooms shall be provided with a hose bib, floor drain, and a 115 Volt, 20 amp receptacle for service tools.
14. Roof mounting of HVAC equipment shall be avoided as much as possible. Where existing conditions are not conducive for achieving an all-indoor equipment installation, the DP shall obtain a waiver from the PROJECT COORDINATOR for mounting equipment on the roof.

1.04 DRAWINGS AND SPECIFICATIONS

A. The Equipment schedules shall list minimum performance and dimensional data as deemed necessary for the project by the DP. Data included on schedules must not be proprietary to one manufacturer.

B. Noise criteria for indoor spaces shall meet the recommendations established by ASHRAE in the Application Handbook. Noise levels outdoors must meet local codes.

C. Design conditions shall be listed on the drawings and shall comply with the following:

	Indoor		**Outdoor**	
	Cooling	**Heating**	**Cooling**	**Heating**
Administrative, media, classrooms, cafeteria, multipurpose rooms, gym & auditorium	74 (1)	70	92 deg DB 80 deg WB	39 deg DB
Kitchen	74			
Locker Rooms[1]	78 (1)	70		
Dry Storage room	74 (1)			
Storage Rooms	74	68		
Note 1: Maintain relative humidity between 50 and 60%.				

D. Ventilation rates shall be incompliance with current codes and ASHRAE standards. A summary of the DPS calculations shall be included on the drawings.

E. Include a building pressurization table on each floor plan, identifying the total amount of outside air, relief, and exhaust air. All buildings shall be designed such that they are slightly positively pressurized.

F. All mechanical rooms shall be air-conditioned using the main air-conditioning system. Provide minimum 50 cfm positive pressure in the room.

G. All MDF rooms and IDF rooms shall be air-conditioned by a split DX system, independent of the building's main air-conditioning system during occupied and unoccupied hours. If possible use a cooling only VAV box or cooling only supply duct off the main cooling system to condition the room during occupied times in addition to the stand alone system for unoccupied hours.

H. Electrical rooms:
   1. For rooms with high heat loads from electrical transformers, provide a dedicated exhaust fan to operate all year round. The fan shall be controlled by a manually adjustable inline thermostat. Make-up air shall be provided from outdoors via an air intake louver (rooms with exterior walls) or roof gravity intake (interior rooms).
      Coordinate with the DP to provide insulated walls and vapor barriers that separate this unconditioned room from adjoining conditioned spaces.
   2. Only electrical rooms that house electronics, such as switchgear, switchboards, transfer switches, etc. shall be air-conditioned by an independent air-conditioning system or provided with a thermostatically controlled fan that exhausts the heat into adjacent spaces and draws air from conditioned areas.

I. Bathroom Exhaust: Dedicated exhaust fans interlocked with lights and provided with adjustable time delay relay (0 to 15 minutes) or central exhaust systems software interlocked with the air handler serving that area.

J. Kiln rooms shall be ventilated and exhausted to maintain 100F or less using outside air. Use wall louver or supply fan (capacity same as the exhaust fan). When cooler transfer/relief air is available from adjacent spaces maintain 85F or less and directly exhaust the room.

1.05 COOLING SYSTEMS FOR NEW SCHOOLS AND RENOVATIONS

A. Air-cooled chillers (minimum two units) with variable primary flow.

B. Mixed air variable air volume (VAV) air handlers, with VAV boxes with electric reheat.

C. Variable air volume air handlers (return air) and decoupled outside air units, with VAV boxes with electric reheat.

D. 100% Outside Air (OA) units (DX) shall be specifically manufactured/designed to handle 100% OA.

E. Fan coil units (return air) with electric reheat and decoupled outside air units.

F. Dual path fan coil units with electric reheat.

G. Wall mounted split systems, inverter type compressor for MDF rooms.

H. Small Constant Volume (CV) DX split systems (3-5 ton systems)

I. Split or packaged DX: the DP shall coordinate with the PROJECT COORDINATOR on a case by case basis.

1.06 NAMEPLATE DATA: Provide permanent plastic (engraved) operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Provide nameplates to the outside of access panels. and nameplate inside of access panel. Locate nameplates in an accessible location.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Store equipment and materials on pallets or acceptable means of dunnage.

B. The CONTRACTOR shall store all materials raised above grade level. Air handling and air distribution equipment shall be stored with all openings sealed until installed in place.

C. Protect all equipment and materials from the weather.

1.08 RECORD DOCUMENTS

A. A set of up-to-date construction drawings and specifications shall be kept at the job site. The CONTRACTOR shall mark drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, tanks, etc.) Changes approved via change orders shall be implemented on these drawings. The book specifications shall be updated in regard to materials and equipment changes.

B. Submit one set of reproducible CAD-generated drawings of the same size as the contract documents and CAD disks with files compatible with the latest version of AutoCAD and PDFs.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following general duty valves common to most mechanical piping systems:
   1. Globe valves
   2. Ball valves
   3. Butterfly valves
   4. Check valves

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Triple duty valves are not to be used.

B. Valves should be all US made, if not available then valve manufacturer shall comply with the Buy American Act.

C. Where insulation is required, provide extended valve stems arranged to receive insulation.

D. Valves sized as same size a pipe.

E. Valve end connections to be as applicable threaded, flanged, or grooved. Soldered connections are only acceptable in refrigerant piping.

F. All valves 2½" and over must be lug-wafer type or flanged and be capable of dead end service

PART 2 – PRODUCTS

2.01 VALVE FEATURES

A. Acceptable manufacturer's unless notes otherwise:
   1. Milwaukee
   2. Stockham
   3. Hammond
   4. Apollo
   5. Victualic

B. Operators:
   1. Handwheels, fastened to valve stem, for valves other than quarter turn.
   2. Lever Handle on quarter-turn valves 6" and smaller, except for plug valves. Provide one wrench for every 10 plug valves.
   3. Chain-wheel operators for valves 2½" and larger installed 72" or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
   4. Gear drive operators on quarter-turn valves 8" and larger.

2.02 BALL VALVES

A. Full port bronze ball valves - ¼" to 2 ½": 600 psig cold water pump, 150 psig steam water pump; MSS SP110. Chrome plated solid machined ball. Handle extensions and locking handles as required.

2.03 PLUG VALVES

A. Plug Valves - 2-1/2" and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

Nordstrom	143
Walworth	1996F

B. Grooved End Plug Valves – 3" and Larger: 175 psi cold water pressure, non-lubricated, eccentric type, ductile iron body and plug, EPDM plug coating, lever handle, gear operator with handwheel, or power actuator, grooved ends.
   Victaulic Series 377

2.04 GLOBE VALVES

A. Globe Valves - 2" and Smaller: MSS SP-80; Class 125, body and screwed bonnet of ASTM B62 cast bronze, threaded or solder ends, brass or replaceable composition disc, copper - silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel. Class 150 valves meeting the above shall be used where pressure requires.

B. Globe Valves - 2" and Smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B62 cast bronze, threaded ends, brass or replaceable composition disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

C. Globe Valves – 2½" and Larger: MSS SP-85; Class 125 iron body and bolted bonnet conforming to ASTM A 126, Class B; outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

2.05 BUTTERFLY VALVES

A. Butterfly Valves 2 ½" and Larger MSS SP-67:

1. Lug Style:	2 – 12"	200 psi	Dead End Service
	12 – 24"	150 psi	Dead End Service

2. Ductile Iron Body
3. Aluminum Bronze Disc
4. Stainless Steel Stem
5. EPDM Seats
6. 10 Position Handle - 2 ½ - 6
7. 8" and Larger Gear Operators

B. Grooved End Butterfly Valves 2" and Larger: 300 psi cold water pressure, ductile iron body conforming to ASTM A 536, electroless nickel-plated or PPS coated ductile iron disc, EPDM or PPS coated seat, and EPDM seals, suitable for bubble-tight shutoff, dead-end and bi-directional service at full rated pressure, lever handle, gear operator with handwheel, or power actuator.

MANUFACTURER	GROOVED ENDS
Victaulic	Vic®-300 MasterSeal™ (2" – 12")
Victaulic	Vic®-300 AGS (14" – 24")

C. Grooved End Butterfly Valves 2 ½" and Larger: 300 psi cold water pressure, copper tube dimensioned bronze body, EPDM coated ductile iron disc, integrally cast steel stem, EPDM seal, suitable for bubble-tight shutoff, dead-end and bi-directional service at full rated pressure, lever handle, gear operator with handwheel, or power actuator.

MANUFACTURER	GROOVED ENDS
Victaulic	Series 608

2.06 CHECK VALVES

A. Swing Check Valves - 2" and Smaller: MSS SP-80; Class 125, cast bronze body and cap conforming to ASTM B62, horizontal swing, Y-pattern, with a bronze disc, and having threaded or solder ends. Valve shall be capable of being reground while the valve remains in the line.

For grooved Connections use Victaulic Series 712.

B. Swing Check Valves - 2" and Smaller: MSS SP-80; Class 150, cast bronze body and cap conforming to ASTM B62, horizontal swing, Y-pattern, with a bronze disc, and having threaded ends. Valve shall be capable of being reground while the valve remains in the line.

For grooved connections use Victaulic Series 712.

C. Swing Check Valves – 2½" and Larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

D. Lift Check Valves 2" and Smaller: Class 250, cast bronze body and cap conforming to ASTM B584, lift type valve, with bronze or stainless spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Valve shall be capable of being refitted and ground while the valve remains in the line.

E. Lift Check Valves 1-1/2” and Smaller: 200 psi cold water pressure, in-line, lift type check valve suitable for installation in horizontal or vertical lines with upward flow, bronze body conforming to ASTM B584, stainless steel spring and stem, TFE disc with stainless steel disc holder.

MANUFACTURER	PUSH-TO-CONNECT
Victaulic	PermaLynx™ 510 Series

F. Spring-Loaded Check Valves 2” and Larger: Suitable for horizontal or vertical installation, ductile iron body conforming to ASTM A395 or A536, stainless steel springs, stainless steel or EPDM coated ductile iron disc, plated nickel, welded-in nickel, or EPDM seat bonded to the valve body.

MANUFACTURER	GROOVED ENDS
Victaulic (2” to 3”)	Series 716H (365 psi)
Victaulic (4” to 12”)	Series 716 (300 psi)
Victaulic (14” to 24”)	Series W715 (230 psi)

2.07 VALVE SELECTION

A. Selection of Valve Ends (Pipe Connections): Except where otherwise indicated, select valves with the following ends or types of pipe/tube connections:
   1. Copper Tube Size 2" and Smaller: Threaded ends.
   2. Steel Pipe Sizes 2" and Smaller: Threaded or grooved-end
   3. Steel Pipe Sizes 2½" and Larger: Grooved-end or flanged

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following general supports, hangers, accessories, fire stopping, etc. for most mechanical piping and equipment systems:
   1. Pipe hangers and supports
   2. Hanger rods
   3. Inserts
   4. Flashing
   5. Equipment curbs
   6. Sleeves
   7. Mechanical sleeve seals
   8. Formed steel channel
   9. Firestopping relating to HVAC work
   10. Firestopping accessories
   11. Equipment bases and supports

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Pipe saddles or roll and stand shall be provided on all floor mounted piping.

B. Shields shall be provided on piping with insulation.

C. All roof mounted equipment (RTU, Fan, etc.) shall have a factory manufactured roof curb. Field fabricated roof curbs are not acceptable. The attachment of the curb to the structure and of the equipment to the curbs shall be designed by a registered structural engineer per the latest applicable codes.

D. Firestopping: Provide UL-listed products and install per manufacturer's installation instructions.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following for identification of mechanical equipment, control panels, valves, piping, etc.:
   1. Nameplates
   2. Tags
   3. Stencils
   4. Pipe markers
   5. Ceiling tacks
   6. Labels
   7. Lockout devices

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 EXTRA MATERIALS

A. Furnish minimum of five percent extra stock of each mechanical identification material required, including additional numbered valve tags for each piping system, additional plastic laminate engraving blanks of assorted sizes.

B. The contractor shall furnish the PROJECT COORDINATOR with one full gallon cans of each finished color and complete manufacturer label and formula, and color chip with manufacturer's color name and/or code and location at which paint occurs.

PART 2 – PRODUCTS

2.01 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved white letters on dark contrasting background color.

B. All HVAC equipment shall be clearly labeled / identified. For equipment installed outdoors, provide stainless steel tags.

2.02 TAGS

A. Valve Metal Tags:
   1. Brass or Stainless Steel with engraved letters; tag size minimum 1-1/2 inches diameter with finished edges. ¼" high letters and ½" high valve numbers.
   2. Provide with solid brass / stainless steel chain or S-hooks for attachment of tags to valves.

B. Valve Schedule Frames: For each page of valve schedule, provide removable glazed display frame. Provide frames of finished hardwood or extruded aluminum with SSB-grade sheet glass. Valve schedules shall be displayed in all mechanical rooms.

2.03 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
   3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inch high letters.
   4. Ductwork and Equipment: 1-3/4 inch high letters.

B. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

C. Label showing pipe size and flow direction

2.04 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers: Provide manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers. Print each pipe marker with arrows to indicate flow direction. For pipes with external diameters less than 6" (including insulation), provide full-band pipe markers, extending 360 degrees around pipe at each location. For pipes with external diameters of 6" and larger (including insulation) provide either full-band or strip-type pipe markers

C. Plastic Underground Pipe Markers:
   1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color-coded head.

B. Color code as follows:
   1. HVAC equipment: Yellow
   2. Fire dampers/smoke dampers: Red
   3. Plumbing valves: Green
   4. Heating/cooling valves: Blue

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Identify air conditioning equipment with nameplates. Identify in-line pumps and other small devices with tags.

F. Identify control panels and major control components outside panels with nameplates.

G. Tag automatic controls, instruments, and relays. Key to control schematic.

H. Identify piping, concealed or exposed, with plastic pipe markers/plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.02 COLOR CODING

A. Refer to section 02500 for color code painting and comply with national color code (ASME A13.1) for piping identification.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following for insulation of ductwork, piping and equipment:
   1. HVAC piping insulation, jackets and accessories.
   2. HVAC equipment insulation, jackets and accessories.
   3. HVAC ductwork insulation, jackets, and accessories.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
   1. CertainTeed
   2. Knauf
   3. Johns Manville
   4. Owens-Corning
   5. 3M

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
   1. Armacell, LLC, Armaflex
   2. Nomaco. K-flex

C. Manufacturers for Foamglas Insulation Products:
   1. Pittsburg Corning.

2.02 PIPE INSULATION

A. TYPE P-1: Foamglas Insulation: Pittsburg Corning Foamglas Super K pipe insulation with a factory applied white all service jacket with self-sealing laps. Minimum 2” foamglas thickness.

B. TYPE P-2: Flexible unicellular piping insulation (Armaflex): Pre-formed split sectional closed-cell pipe insulation. Suitable for operating temperatures of -40º F to +220ºF. Thermal conductivity "K" factor of 0.27.

2.03 PIPE INSULATION JACKETS

A. Field Applied Glass Fiber Fabric Jacket System (interior piping):
   1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   2. Glass Fiber Fabric:
      a. Cloth: Untreated; 9 oz/sq. yd. weight.
      b. Blanket: 1.0 lb/cu. ft. density.

c. Weave: 5 x 5.
3. Lap joints a minimum three inches.

B. Aluminum Pipe Jacket (exterior piping and mechanical rooms):
1. ASTM B209.
2. Thickness: 0.016 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.015 inch thick aluminum.

2.04 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Insulation Protection Shield / Saddle: As recommended by insulation manufacturer.

D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum stainless steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

E. Fittings: Provide fitting coverings of a similar material and thickness as adjacent pipe coverings. Cover all elbows, tees, valves, flanges and other fittings of piping system.

F. Accessories: All staples, bands, wires, adhesives, cements, sealers and protective finishes to be as recommended by insulation manufacturers.

2.05 EQUIPMENT INSULATION

A. Foamglas Insulation: Pittsburg Corning Foamglas Super K pipe insulation with a factory applied white all service jacket with self-sealing laps. Minimum 2” foamglas thickness.

2.06 EQUIPMENT INSULATION JACKETS

A. Aluminum Equipment Jacket :
1. ASTM B209.
2. Thickness: 0.025 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

B. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2. Glass Fiber Fabric:
   a. Cloth: Untreated; 9 oz/sq. yd. weight.
   b. Blanket: 1.0 lb/cu. ft. density.
   c. Weave: 5 x 5.

2.07 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Accessories: All staples, bands, wires, adhesives, cements, sealers and protective finishes to be as recommended by insulation manufacturers.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.08 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.27 at 75ºF.
   2. Maximum Operating Temperature: 250ºF.
   3. Density: 0.75 pound per cubic foot.
   4. Installed R-value shall be 6.0 minimum.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.23 at 75º F.
   2. Density: 4.25 pound per cubic foot.
   3. 1 ½" thick.

C. TYPE D-3: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
   1. Thermal Conductivity: 0.42 at 500º F.
   2. Weight: 1.4 pound per square foot.
   3. Flame spread rating of 0 and smoke developed rating of 0 in accordance with ASTM E84.
   4. 1 ½" thick per layer, two (2) layers required and installed per manufacturer's requirements to meet UL listing.

D. TYPE D-4: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.22 at 75ºF.
   2. Density: 6 pound per cubic foot.
   3. 2" thick.

2.09 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Jacket:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive only for indoor installations.
   2. Outdoor Jacket: Self-adhering membrane with UV resistant aluminum weathering outer layer and high-density, cross-linked polymer film underneath. Adhesive shall be rubberized asphalt, flex clad 400 or approved equal.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Lagging Adhesive: Fire resistive to ASTM E84, NFPA 255, UL 723.

F. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

G. Adhesives: Compatible with insulation.

H. Membrane Adhesives: As recommended by membrane manufacturer.

I. Provide pressure sensitive duct tape over seams and joints. Apply vapor seal mastic over all taped seams and joints.

2.10 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	PIPE SIZE	TYPE	THICKNESS (INCHES)
Chilled Water Supply and Return 40 to 60 degrees F	3/4 inch and smaller 1 inch and larger	P-1	1.5 2.0
Condensate Piping from Cooling Coils	All sizes	P-2	0.75
Refrigerant Suction	All sizes	P-2	0.75
Refrigerant Hot Gas	All sizes	P-2	0.75

B. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE
Combustion Air	D-2
Outside Air Intake	D-2
Equipment Casings	D-2
Supply Ducts (externally insulated) (indoors)	D-1
Return Ducts (externally insulated) (indoors)	D-1
Kitchen Exhaust Duct	D-3
Supply, Return, and Outdoor Air Ductwork in Mechanical Rooms and Exposed Areas. (indoors)	D-2
Supply and Return Air Ductwork Outdoors	D-4

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. Section includes: Pipe and pipe fittings for the following systems:
   1. Chilled water piping
   2. Equipment drains and over flows
   3. Unions and flanges
   4. Underground pipe markers

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Utilize valve boxes and shut off valves for each building entrance for site piping.

B. Size chilled water piping at maximum 4.0/100Ft pressure drop.

C. Provide dedicated isolation valves on both supply and return piping at all coil connections.

D. Provide American made piping where available. Coordinate with PROJECT COORDINATOR for a waiver when necessary.

PART 2 – PRODUCTS

2.01 CHILLED WATER PIPING, BURIED

A. Pre-Insulated Pipe with steel carrier pipe, polyurethane foam insulation and extruded, black, high density polyethylene (HDPE) jacket with minimum wall thickness of 125 mils for jacket sizes less than or equal to 12”, 150 mils for jacket sizes larger than 12” to 20”. The following shall be included:
   1. Rubber end seals shall be high temperature (HT) heat resistant ethylenediene monomer (EPDM) molded rubber compound. All surfaces shall be smooth and free of voids.
   2. Fittings shall be field-insulated by CONTRACTOR using materials supplied by the pre-insulated pipe manufacturer.

B. FRP Jackets are not allowed.

C. Approved manufacturers: Thermal Pipe Systems, Inc. and Thermacor Process L.P.

2.02 CHILLED WATER PIPING ABOVE GROUND (LESS THAN 125 PSI)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, seamless. (2-1/2" and larger)
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, black, seamless, grooved ends.
   1. Fittings: ASTM A234/A234M carbon steel, grooved ends.
   2. Fittings: Factory Grooved End Fittings equal to Victaulic Full-Flow. Tees shall be equal to Victaulic Style 20, 25, 27, or 29.
   3. Joints: Mechanical Couplings equal to Victaulic couplings Style 75 or 77 with Grade H gaskets, lubricated per manufacturer's recommendations.
   4. Grooved fitting shall not be located in concealed spaces.

C. Copper Tubing (2" and smaller):
   1. ASTM B88, Type K, hard drawn, annealed.
   2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   3. Use threaded fittings for connections to equipment or devices. Soldered fittings are not acceptable.
   4. Mechanical fittings, crimp or flair, are not permitted.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. PVC Pipe: ASTM D1785, Schedule 40.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: ASTM D2855, solvent weld.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following hydronic specialties for chilled water and heating water systems:
   1. Pressure gages and taps
   2. Thermometers and supports
   3. Flexible connectors
   4. Expansion tanks
   5. Air vents
   6. Air separators
   7. Strainers
   8. Pump suction fittings
   9. Combination pump discharge valves
   10. Flow controls
   11. Flow meters
   12. Relief valves

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. The controls contractor shall provide motorized control valves, flow switches, temperature sensors, sensor sockets, well gas taps, etc. and installed by the mechanical contractor.

B. Locations of all sensor sockets, flow switches and taps shall be coordinated and supervised by the controls contractor.

C. Provide suction diffusers at base mounted pumps where sufficient straight pipe runs cannot be achieved.

D. Use diaphragm-type expansion tanks. ASME rated for 125 psi working pressure.

E. Manual air vents shall be located in highest part of system, in accessible location.

PART 2 – PRODUCTS

2.01 PRESSURE GAGES

A. Gage: ASME Grade 2A with reinforced polypropylene or 316 stainless steel casing bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background, +/- .05% accuracy, liquid filled.

2.02 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, non-mercury, lens front tube, cast aluminum case with enamel finish, ±1% accuracy.

2.03 FLEXIBLE CONNECTORS

A. Corrugated stainless steel bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with steel flange ends; for maximum working pressure 150 psig.

2.04 BLADDER-TYPE EXPANSION TANKS

A. Construction: Welded steel with heavy-duty butyl replaceable bladder. Tank shall be supplied with a ring base, lifting rings and NPT system connection.

B. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.05 AIR SEPARATORS

A. In-line Air Separators: Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger.

B. Combination Air Separators/Strainers: Steel with integral strainer, tangential inlet and outlet connections.

2.06 STRAINERS

A. Size 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen

B. Size 2-1/2 inch to 6 inch: Flanged iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 8 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.07 PUMP SUCTION FITTINGS

A. Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. With inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

B. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.08 COMBINATION PUMP DISCHARGE VALVES

A. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.09 FLOW CONTROLS

A. Brass or bronze body with union on outlet, temperature and pressure test plug on inlet and outlet.

B. Calibration: Control within 5 percent of design flow over entire range of operating pressures.

2.10 FLOW VENTURIS AND METERS

A. 2” and Smaller: Brass threaded or steel; match piping material. Accuracy ±1%.

B. Furnish a chained metal tag showing Venturi size, location, GPM and differential in inches of water for GPM. Permanent head loss requirement not to exceed 10% of differential pressure reading.

C. On all lines ½”, ¾”, and 1” through 7 GPM, provide a positive shut-off ball valve with memory lock, threaded or sweat, to a fixed-type orifice (Balvalve-Indicator). Each orifice shall use push-type quick disconnects and include a chained metal tag showing orifice size, location, GPM and differential pressure in inches of water at design GPM. The device shall be capable of measuring down to .2 GPM. Accuracy ±1%.

D. Where specified by DP, provide direct reading GPM meters to indicate GPM flow on specific Venturis.

2.11 FLOW METERS

A. Manufacturers:
   1. Onicon

B. Electro Magnetic, Series 3000 or 3500 depending on application. Coordinate with PROJECT COORDINATOR on project by project basis.

C. BACNET/JCI Metasys compatible.

D. Provide with flow display D-100 and temperature sensors and wells (on supply and return).

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes refrigerant piping and refrigerant piping specialties.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Follow manufacturer's requirements for length of run, vertical lift, refrigerant pipe sizing and required accessories.

B. When equipment capacities are de-rated due to refrigerant piping losses, ensure design requirements are still met.

PART 2 – PRODUCTS

2.01 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.02 UNIONS, FLANGES, AND COUPLINGS

A. Copper Pipe: Bronze, soldered joints.

2.03 VALVES

A. Manufacturers:
   1. Alco Controls Div, Emerson Electric Co.
   2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
   3. Sporlan Valve Co.

B. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, solder ends.

C. Refrigerant Valve and Gages:
   1. Provide valves on compressor suction and discharge (if not provided by manufacturer).
   2. Provide taps at compressor inlet and outlet (if not provided by manufacturer).
   3. Provide frigerant charging valve in liquid line between receivers' shut-off valve and expansion valve (if not provided by manufacturer).

2.04 REFRIGERANT SPECIALTIES

A. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, minimum 100 mesh, UL-listed.

B. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections.

C. Refrigerant Filter-Dryers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core.

D. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.

E. Acceptable manufacturers of refrigerant specialties are Alco Controls Div.; Emerson Electric Co., Henry Valve Co., Parker-Hannifin Corp. (Refrigeration & Air-Conditioning Div.), and Sporlan Valve Co.

2.05 SUPPORTS AND ANCHORS

A. Except as otherwise indicated, provide factory fabricated supports and anchors complying with MSS SP-58, in accordance with MSS SP-69 and manufacturer's published product information.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes requirements for pumps.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Acceptable Chilled water pumping distribution schemes:
   1. Chillers up to 140 tons, use constant volume pumping with 3-way valves. Provide a VFD for balancing constant volume pumps.
   2. Chillers more than 140 tons use Variable primary flow with VFDS with manifold so each chiller pump can provide flow through any chiller. Provide chilled water bypass line size based on largest chillers minimum flow rate.
   3. Provide proper clearances for servicing pumps in mechanical rooms and chiller yards. Provide no less than minimum recommended by the manufacturer.

PART 2 – PRODUCTS

2.01 PUMPS

A. Manufacturers:
   1. Bell & Gossett
   2. Armstrong
   3. Aurora
   4. TACO
   5. Patterson

B. Base mounted pumps shall be long coupled, base mounted, single stage, end suction, vertical split case design, in cast iron bronze fitted (or all bronze or all iron) construction specifically designed for quiet operation.

C. Base mounted pumps shall be composed of three separable components a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler. A bearing assembly shall support the shaft via two heavy-duty regreaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end.

D. Shaft: 316 stainless steel

E. Impeller: bronze. Impeller shall be both hydraulically and dynamically balanced at the factory.

F. Base mounted Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.

G. Base mounted pump center drop-out Coupler shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections.

H. Pump volute shall be of a cast iron design. Volute shall include gauge ports at nozzles, and vent and drain ports.

I. Motors shall be premium high efficiency with class F insulation. Non-overloading TEFC motors.

J. For Base mounted pumps the base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting).

K. Vertical Inline Split Pumps shall have high tensile strength aluminum coupler. Motor mounted impellers unacceptable above 5 hp.

L. For Vertical Inline Split Pumps Supply a 50 micron cartridge filter and sight flow indicator in the flush line to the mechanical seal, to suit the working pressure encountered. Filters shall be changed, by the Installing CONTRACTOR, after system is flushed and on a regular basis until turned over to the PROJECT COORDINATOR.

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. This section includes air-cooled condensing units.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

PART 2 - PRODUCTS

2.01 AIR-COOLED CONDENSING UNITS

A. Acceptable Manufacturers:
   1. Carrier
   2. Trane
   3. York

B. General: Factory-assembled and tested air-cooled condensing units, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Unit shall be complete with brass service valves, fittings, and gauge ports on exterior of casing.

C. Casing: Galvanized steel finished with baked enamel.

D. Compressor: Hermetically sealed, with built-in overloads and vibration isolation. Compressor motor shall have thermal and current sensitive overload devices, internal high-pressure protection, high and low pressure cutout switches, start capacitor and relay, two-pole contactor, crankcase heater, and temperature actuated switch and timer to prevent compressor rapid cycle. Provide service access valves on suction and discharge ports.

E. Capacity Control: Cylinder unloading, multi-compressor staging, digital compressors and inverted/variable speed compressors.

F. Low Ambient Control: Factory-installed low ambient damper assembly, fan speed control, or fan cycling control.

G. Provide hot gas bypass on one circuit for VAV applications.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes air cooled chillers consisting of Scroll and Screw type compressors.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Chiller types and acceptable chilled water pumping distribution schemes:
   1. Air cooled chillers up to 140 tons, use scroll type compressors and constant volume pumping with 3-way valves. Provide a VFD for balancing constant volume pumps.
   2. Chillers more than 140 tons use screw type compressors and Variable primary flow with VFDS with manifold so each chiller pump can provide flow through any chiller. Provide chilled water bypass line size based on largest chillers minimum flow rate.
   3. Chillers shall have a minimum of two independent refrigerant circuits when available.
   4. For Variable Primary Flow applications the chiller must be capable of variable primary flow through the evaporator with no less than 30% rate of change in flow per minute while still keeping the temperature within +/- 2º F of set point.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide air-cooled chillers by one of the following:
   1. Carrier
   2. Trane
   3. JCI/York Products

2.02 OUTDOOR CHILLERS

A. Factory assembled, single-piece or factory configured duplex chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, and controls. Refrigerant charge R410A is preferred, if not available then R134 is acceptable.

B. Efficiency: Chiller shall meet the operating efficiency as rated in accordance with the ARI and the Florida Energy Code.

C. Provide manufacturer factory start-up.

D. Provide factory installed 1.25” UV resistant Armacell evaporator insulation. On screw chillers suction elbow must be insulated.

E. For non VFD chillers provide with a WYE Delta starter. Across the Line Starters are acceptable for scroll compressors only.

F. For screw chillers with a VFD, provide unit mounted variable frequency drive with a circuit breaker with a 65,000 AIC interrupt rating. VFD design shall include as standard integrated active rectification control system to limit total demand distortion (TDD) in current at the VFD to less than or equal to 5 percent. If active filters are used to meet less than or equal to 5% TDD, then the losses associated with the filter shall be included in the chiller performance on the selection.

G. Scroll chillers are to be provided with:

1. Factory installed lead/lag operation and advanced motor protection.

2. Factory installed strainer and blow down valve.

3. Factory installed circuit breaker with 65,000 AIC short circuit rating for chiller and for each compressor on the electrical circuit

H. Factory installed thermal dispersion flow switch as manufactured by IFM.

I. Provide a condenser coil coating with a minimum of 5,000 hours in the ASTM B-117 salt spray test. Coating may not decrease heat transfer by more than 1%. Adsil Microguard and Luvata Insitu are approved. Bake phenolic coatings are not acceptable.

J. Provide factory installed BACNET interface and full access to all points, read/write.

K. Provide with factory wired control power transformer.

L. Provide five years parts, labor and refrigerant warranty on the entire chiller.

2.03 CONTROLS, SAFETIES, AND DIAGNOSTICS

A. Unit controls shall include the following minimum components:
1. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
2. Power and control circuit terminal blocks.
3. ON/OFF control switch
4. Auto-restart after power failure.
5. Replaceable solid-state relay panels.
6. Thermistor installed to measure saturated condensing temperature, cooler saturation temperature, compressor return gas temperature, and cooler entering and leaving fluid temperatures.
7. Energy Management Control Module: A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-point demand limit control (from 0 to 100%) activated by a remote contact closure. The chiller shall also include fully accessible BACNET interface over MSTP. All points available at the

chiller control panel shall be made available at the front end computer. The chiller manufacturer's representative shall coordinate with PCSB and the controls CONTRACTOR for implementation.

8. Leaving chilled fluid temperature reset from return fluid, outdoor-air temperature, space temperature, and 4 to 20 mA input. PCSB shall have the ability to choose reset means through the building controls system.
9. The control system shall allow software upgrade without the need for new hardware modules. The chiller manufacturer is responsible for upgrading chiller's controls software at chiller's initial start-up and throughout the first year of warranty to the latest version available at no extra cost to the PROJECT COORDINATOR.

2.04 ELECTRICAL REQUIREMENTS

A. Unit primary electrical power supply shall enter the unit at a single location single point power connection (some units have multiple poles). Unit shall be shipped with factory control and power wiring installed.

2.05 SPECIAL FEATURES

A. Special Features:
   1. Security Guards: Unit shall be supplied with factory (or field) installed Architecturally Louvered Panels to protect the complete condensing unit and the service area beneath the condenser.
   2. Sound Reduction Enclosures: If Factory Installed acoustical kit is not sufficient to meet acoustics, provide Field-installed accessory kit shall include sheet metal hoods with sound absorbing panels designed to reduce sound levels.
   3. Provide Vibration isolation pads for field installation at unit mounting points.
   4. Provide GFI Convenience Outlet when there are no existing receptacles.
   5. Cooler Head Insulation: Unit shall be supplied with field-installed cooler insulation that shall cover the cooler heads.
   6. Suction Isolation Valves: Unit shall be supplied with factory-installed suction isolation valves.

2.06 ACOUSTICS

A. Sound pressure for the unit shall not exceed the following specified levels. Lower levels may be necessary due to project's specific location and shall be enforced by the engineer of record on a project-by-project basis.
   1. Scroll Chillers:

Sound Pressure at 100% Load, dBA	
30 feet from coil side	65
30 feet from control panel end	61

Sound Power at 100% Load, dBA	93
NOTES: *1. Chiller Height Above Ground 0.0 ft.* *2. Horizontal Distance From Chiller to Receiver 30.0 ft.* *3. Receiver Height Above Ground 6.0 ft.*	

2. Screw Chillers:

Sound Pressure at 100% Load, dBA	
30 feet from coil side	70
30 feet from control panel end	68
30 feet from end opposite control panel	66

Sound Power at 100% Load, dBA	98
NOTES: *1. Chiller Height Above Ground 0.0 ft.* *2. Horizontal Distance From Chiller to Receiver 30.0 ft.* *3. Receiver Height Above Ground 6.0 ft.*	

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. This section includes the requirements for small DX HVAC systems 3 tons and smaller:
   1. Small Packaged split systems including indoor air handlers (wall & ceiling mounted) and their associated condensing units.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. These types of systems are used at Main Distribution Frame (MDF) rooms, Dry Storage, Intermediate Data Frame (IDF) Rooms, etc. in cooling mode only.

B. Condensing units shall be mounted on a minimum 4“ concrete slab.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers:
   1. Daikin AC
   2. LG
   3. Mitsubishi

2.02 SPLIT SYSTEMS

A. The system performance shall be in accordance with ARI 210/240 test conditions.

2.03 REFRIGERANT PIPING

A. The system shall be capable of handling long refrigerant lines – horizontal and vertical – as required by project design criteria, without any oil traps or additional components. Any reduction in capacity due to refrigerant losses shall be identified in the submittal.

2.04 OUTDOOR UNIT

A. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a scroll compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and liquid receivers.

B. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.

C. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heater, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timer.

D. The outdoor unit shall be capable of cooling & heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

E. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

F. The compressor shall be variable speed (inverter) controlled and is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
   1. Oil separators shall be standard with the equipment together with an intelligent oil management system.

2.05 INDOOR UNIT – WALL OR CEILING MOUNTED UNIT

A. The indoor unit shall be wall or ceiling mounted fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

B. The unit shall have BACnet interface for connection to BMS system. Coordinate with PROJRCT COORDINATOR for project requirements (i.e. start/stop only, full control, etc.).

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. This section includes packaged roof mounted 100% Outside Air (OA) units, pad mounted 100% OA units and split 100% OA units.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. The OA units shall be specifically designed and factory-built to dehumidify 100% outside air. Field modified equipment is not acceptable.

B. Acceptable manufacturers:
   1. Addison Products Co
   2. Valent
   3. Desert Aire
   4. Aaon
   5. Dectron Internationale, Inc.

C. Provide manufacturer factory start-up. Replace damaged or malfunctioning controls and equipment.

D. Factory controller shall have BACnet interface for connection to BMS (JACE)

PART 2 - PRODUCTS

2.01 DX EQUIPMENT FEATURES

A. Double wall casing construction is preferred when available. Provide removable panels and/or access doors for inspection and access to internal parts. Insulate casing to prevent condensation.

B. Support
   1. Roof installation: Provide code compliant, pre-manufactured insulated roof curb. Field fabricated curbs are not acceptable.
   2. Ground installation: provide concrete pad with dimensions that extend 4” beyond the perimeter of the unit and elevate the unit such that the lowest part of its base is 6” above grade. If multiple units specified in one area use large pad and install close to the building edge.

C. Wind Load Compliance: Provide hurricane strapping or other means of structural reinforcement to comply with Florida Building Code. A Florida registered structural engineer shall design the attachment of the unit to the curb/pad and of the curb to the structure.

D. Provide refrigerant thermal expansion valve for refrigerant control. Provide access valves in suction and liquid lines. Provide dual refrigeration circuits for dual compressor units. Provide filter/dryers and site glass.

E. Provide multiple stages of cooling. Provide variable speed compressors where available Digital scroll compressors are to be considered next. If preferred options are not available, then use hot gas bypass.

F. Provide hot gas reheat capable of increasing the leaving air dry bulb temperature from the packaged unit to a minimum of the space dry bulb set point. Reheat shall be controlled by a modulating refrigerant thermal expansion valve, capable of controlling reheat temperature to ± 2°F.

G. Provide direct drive fans with factory mounted and wired VFDs to eliminate belt losses and maintenance. Provide permanently lubricated fan and motor bearings, and thermal overloads in motor.

H. Provide metal mesh pre-filter if the unit is ducted to air handlers. If the supply is ducted directly to the spaces (decoupled outside air system), then also use a 2 inch pleated final filter.

I. Provide low ambient control based on head pressure, designed to operate at temperatures down to 20ºF.

J. Unit should have direct drive, electronically commutated motors on the condenser fans, capable of variable speed, to properly match head pressure requirements without cycling the condenser fans. Unit should hold the cooling coil leaving air temperature within +/- 1ºF.

K. Electric Heat (if applicable): Utilize SCR control.

L. The air handler cabinet shall be constructed of G-90 galvanized steel.

M. The air handler coil shall be intertwined with high latent heat capacity. The outside air coil face velocity shall not exceed 400 feet per minute or lower if recommended by the manufacturer to prevent water carry over.

N. The condensate drain pan shall be sloped and fabricated from stainless steel. The bottom shall then be insulated to prevent condensation. The drain pan shall be furnished with single or dual MPT drain fittings positioned at the exterior of the cabinet.

O. Provide a condenser coil coating with a minimum of 5,000 hours in the ASTM B-117 salt spray test. Coating may not decrease heat transfer by more than 1%. Adsil Microguard and Luvata Insitu are approved. Bake phenolic coatings are not acceptable.

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. This section includes the requirements for packaged split system air handling units (1-5 tons):
   1. Indoor vertical draw-through
   2. Indoor horizontal draw-through

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. These system types are typically used in applications with 15% or less outside air ventilation requirements or utilized with a decoupled 100% OA unit.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Carrier

B. Trane

C. York

2.02 GENERAL

A. Air handler units shall be completely factory assembled including coil, condensate drain pan, fan motor(s), filters, and controls in an insulated casing that can be applied in either vertical or horizontal configuration. Units shall be rated and tested in accordance with ARI Standards and shall be UL listed and labeled.

2.03 CASING

A. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surface shall be weather-resistant baked enamel finish. Casing shall be completely insulated, double-walled construction when available. Closed cell foam insulation or cleanable, foil faced, fire-retardant, permanent, odorless glass fiber material are acceptable when double-walled construction is not available. All insulation edges shall be either captured or sealed.

2.04 FANS

A. Direct drive fans are preferred. Thermal overload protection shall be standard on motor. Fan and motor bearings shall be permanently lubricated.

2.05 MOTORS AND DRIVES

A. All motors shall be resilient mounted, electronically commutated motor (ECM) with UL-listed thermal overload protection. Electrical junction boxes shall be provided for single point power connection.

2.06 COILS

A. Configured aluminum fin surface shall be mechanically bonded to 3/8" internally enhanced copper tubing and factory pressure and leak tested at 375 psig. Coil is arranged for draw-through airflow and shall provide a double sloped condensate drain pan constructed of PVC plastic. The drain pan shall be removable for cleaning. The condensate drain pan can be installed in any of four positions allowing for vertical or horizontal application and providing external connections on either side of the unit.

2.07 CONTROLS

A. Magnetic evaporator fan contactor, low voltage terminal strip, check valve(s), and single point power entry shall be included. All necessary controls shall be factory installed and wired. Evaporator defrost control shall be included to prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered.

B. The DP shall coordinate with the PROJECT COORDINATOR if DDC type thermostats (refer to section 15975) are to be used on the project on a case by case basis.

2.08 ELECTRIC HEATERS

A. Electric heaters shall be available in a wide range of capacities with one or two stage control, single-point electric power connection and terminal strip connections.

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. Section includes power ventilators.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. No equipment should be installed on the roof unless required by code for certain systems or a written approval from PCSB is obtained. Locate fans above the ceiling or in mechanical rooms. Avoid locating fans above classrooms or any other sound sensitive applications.

B. Conditioned group restroom fans shall be interlocked with the local air handler unit or outside air (OA) unit when applicable or controlled by the EMS to be scheduled during occupied hours.

C. Individual restroom exhaust fans can be interlocked with the air handler or the room light switch. When switched with lights provide a 10 minute time delay.

END OF SECTION

PART 1 - GENERAL

1.01 EXTENT OF SECTION

A. This section includes the following:
   1. Modular indoor draw-through air handling units
   2. Modular indoor blow-through air handling units

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP..

1.02 DESIGN CRITERIA

A. Provide proper clearances for servicing including coil pull.

B. New construction and new mechanical rooms: maintain a minimum of 36 inches clearance around air handlers.

C. Existing mechanical rooms, where 36 inches is not possible due to existing conditions coordinate with the PROJECT COORDINATOR for a waiver.

D. Air handlers shall be fully ducted. Mechanical rooms shall not be used as a return air plenum.

E. Provide mechanical room pressurization to prevent condensation on equipment. Refer to Section 15010, Basic Mechanical Requirements.

F. Coils shall be maximum 10 fins per inch and selected equal to or less than 15FT water pressure drop.

G. Select coils with a maximum air velocity of 500 feet per minute. In applications with high percentages of outdoor air, reduce the coil velocity to 400 feet per minute, as needed to avoid water carryover.

H. For VAV applications, utilize VFD compatible motors and variable frequency drives (VFD).

I. Install air handlers on concrete pads that allow for condensate drainage and piping. An extended base rail shall be used when additional height is necessary.

J. In applications with high percentages of outside air and constant volume airflow, specify separate outside air coils (i.e. dual path air handlers).

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Acceptable manufacturers:
   1. Carrier “Aero”
   2. Trane “Performance Climate Changer”
   3. York “Solutions”

2.02 CASING

A. Unit shall be true modular construction such that individual modules can be easily separated for ease of installation in tight spaces.

B. Access panels/doors shall be provided for access to all components. Where doors cannot fully open, provide removable panels.

C. All exterior panels and structural frames shall be constructed of G90-U galvanized steel.

D. All joints between exterior panels and structural frames shall have seals and gaskets with closed-cell foam gasketing for air seal and acoustical break.

E. Access doors shall be double-wall construction.

F. Unit casing panels shall be 2-inch foam filled double-wall construction with solid galvanized exterior and solid galvanized interior. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13Hr*Ft2*°F/BTU.

G. Acoustical performance shall be provided per ARI 260 procedures for the entire unit. Fan only acoustical performance or estimated sound data is not acceptable. Sound data for each sound path, in the 63 Hz through 8000 Hz bands shall be provided. Sound data by octave band by path, shall be supplied that meets or is lower than the project requirements.

H. Cabinets must have a leakage rate not greater than 1% at 8” total static pressure at design airflow in accordance with ASHRAE 111 leakage class 6.

2.03 FANS

A. Fans shall be tested, rated and certified in accordance with ANSI/AMCA Standard 210 for air delivery and in accordance with AMCA Standard 300 for sound power levels and shall bear the AMCA seal. The fan balancing process, including vibration limits and documentation, shall be performed in accordance with ANSI/AMCA Standard 204. Maximum rated speed of the fans shall not exceed 75% of the first critical speed.

B. Fan shafts shall be solid steel, 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 selected with inverter balancing shall have maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.

C. Fans and motors shall be internally isolated with spring isolators.

D. All plenum fans shall have airfoil blades.

2.04 MOTORS AND DRIVES

A. Fans shall be direct drive. Use of belt driven fans is acceptable when approved by the PROJECT COORDINATOR on a project-by-project basis.

B. Fan Motors shall be heavy duty, high efficiency, open drip-proof, operable at scheduled voltage.

C. For VAV applications motor shall be invertor duty rated and labeled.

2.05 COILS

A. Install coils such that headers and return bends are enclosed by unit casings.

B. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

C. Construct coil casings of stainless 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.

2.06 DRAIN PAN CONSTRUCTION

A. The drain pan shall be double sloped, constructed of stainless steel and insulated to prevent sweating.

2.07 FILTERS / MIXING BOX

A. 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, removable access doors for filter removal. Provide filter blockoffs as required to prevent air bypass around filters.

B Provide combination filter mixing box when space allows.

C. Provide factory installed airfoil return and outside air dampers with blade and jamb seals not to exceed AMCA Class 1A leakage. The actuator shall be provided by the controls CONTRACTOR.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. Section includes Variable Frequency Drives (VFD).

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. ABB

B. Danfoss

C. Mitsubishi

D. Square D

E. Toshiba

F. Trane

G. Yaskawa

H. York Modular Drives

2.02 GENERAL

A. All standard and optional features shall be included within the VFD enclosure. VFD shall be housed in a metal NEMA 1 enclosure when installed indoors, and in NEMA 4X for outdoor installation.

B. The VFD shall have auxiliary contact to support fan shut-down by the fire alarm system.

C. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

D. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter, and a four-position DRIVE/OFF/LINE/TEST switch controlling three contactors. The DP shall coordinate with the PROJECT COORDINATOR for providing VFDs without bypass where applicable.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section contains the requirements for metal and flexible ductwork.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

PART 2 – PRODUCTS

2.01 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

B. Steel Ducts: ASTM A1008/A1008M, ASTM A1011/A1011M, ASTM A568/A568M.

C. Stainless Steel Ducts: ASTM A167, Type 304L.

D. Fasteners: Rivets, bolts, or sheet metal screws.

E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
   1. Where dissimilar metals are used, provide dielectric unions/separators.

2.02 FLEXIBLE DUCTS

A. Use of flexible ductwork is restricted to 5 ft. in length.

B. ULC-S110 and UL 181, approved product, dead soft aluminum strip, spirally wound and mechanically joined together to form an airtight and leakproof triple lock seam. Allowable on exhaust systems, where the use of hard ductwork is not feasible due to existing field conditions.

C. Corrosive resistant steel helix mechanically locked to a trilaminate inner fabric or corrugated aluminum; complying with UL 181. Provide one inch (1") thick continuous flexible fiberglass sheath with reinforced aluminum material vapor barrier jacket. Allowable on supply systems, for connecting air devices to branch ductwork. Hard elbows must be provided at air devices connections and at all changes in direction.

2.03 SINGLE WALL SPIRAL ROUND DUCTS

A. UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

B. SMACNA RL-8 button lock, supplied with factory installed butyl gasket that once snapped together is self-sealing, requiring no additional sealing of the longitudinal or transverse joint. Gasket must have zero VOC's and must meet the requirements of ASTM E84-05.

C. Construct fittings with the following minimum gages, unless SMACNA requirements are more stringent in which case they apply:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.04 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards". Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Cross-breaking or Cross Beading: Cross-beak or bead duct sides that are 19" and larger and are 20 gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard", unless they are lined or are externally insulated.

2.05 DUCT APPLICATIONS

A. Supply, return and outdoor air systems: Galvanized ductwork

B. Exhaust air systems: Galvanized ductwork or flexible aluminum where allowed.

C. Kitchen / Dishwasher Exhaust: Stainless steel, continuously welded.

D. Hazardous Exhaust Systems: Galvanized, stainless or PVC. To be coordinated with the PROJECT COORDINATOR on a project by project basis.

2.06 DUCT CONSTRUCTION

A. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Supply	Greater value between 3 inch wg and construction documents set value
Return and Pressure Relief	Greater value between 3 inch wg and construction documents set value
General Exhaust	Greater value between 2 inch wg and construction documents set value
Dishwasher Exhaust	Greater value between 2 inch wg and construction documents set value
Kitchen Hood Exhaust	Greater value between 4 inch wg and construction documents set value

B. Protect open ductwork from construction debris during installation and construction

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section contains the requirements for ductwork accessories such as:
   1. Dampers: Balancing dampers, Low pressure manual dampers, Control dampers, Counterbalanced relief dampers, Automatic backpressure dampers, Fire Dampers, Fire/Smoke dampers, Smoke dampers.
   2. Turning vanes
   3. Duct hardware
   4. Duct access doors
   5. Flexible connections

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Utilize ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to insure that products serve intended function. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

B. Use turning vanes in square or rectangular 90º elbows in supply air systems, and elsewhere as indicated.

C. Access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

D. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

E. UL Compliance: Fire dampers to be UL listed.

F. NFPA Compliance: Comply with applicable provisions of NFPA 90A, "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

G. Comply with 2010 Florida Building Code, Energy Conservation.

H. Stand-alone smoke damper shall be a DSDF (flow rated smoke duct detector) and smoke damper. The damper and DSDF are to be 120vac. The smoke dampers are to close and shut down the air handling unit. The smoke damper with the DSDF is installed and warranted by the mechanical CONTRACTOR. The smoke damper and DSDF is not controlled by, or powered by, the fire alarm system. The fire alarm system only supervises the smoke damper via a monitoring module.

PART 2 – PRODUCTS

2.01 DAMPERS

A. Low Pressure Manual Dampers: Provide dampers of multi-blade with opposed blade arrangement for balancing and parallel blade arrangement for on/off applications.

B. Control Dampers: Provide dampers with parallel blades or 2 position control, or opposed blades for modulating control.

2.02 FIRE AND SMOKE DAMPERS

A. Provide fusible link rated at 160°F to 165°F unless otherwise indicated.

B. Construction shall meet UL- listing for installation and application.

C. For ceiling dampers provide minimum ¼" thick ceramic insulating blanket as required by air device and manufacturers tested assembly. .

D. Each combination fire smoke damper shall be equipped with a UL classified firestat package. Firestat package shall function to electrically lock damper in a closed position when duct temperatures exceed 165°F and still allow for override as may be required for smoke control functions. Each combination fire/smoke damper shall have pressure drops in the open position of less than 0.1 inch w.g. with average duct velocities of 2500 fpm.

E. Provide dynamically rated fire dampers in supply, return, and relief ductwork. Provide static type in transfer ductwork.

F. Acceptable manufacturers include Ruskin Mfg., Air Balance, Inc., Greenheck, and Prefco Products, Inc.

2.03 DUCT HARDWARE

A. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft, and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Conical Fittings or 45° fittings: Provide fittings with gasket on flange, seams fully and continuously welded. Riveted or spot welded seams are not acceptable.

C. High efficiency take offs with factory applied gasket along all rivets, co-latches, and flange are acceptable.

2.04 ACCESS DOORS

A. Construct access doors of the same or greater gauge as ductwork served, provide minimum 1" thick insulated doors for insulated ductwork. Provide flush frames for

uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with on handle-type cam latch for all doors. Installation of door shall be accessible, and the size opening shall be large enough to permit maintenance and resetting of device the door serves.

2.05 FLEXIBLE CONNECTIONS

A. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the requirements for air devices in HVAC systems:
   1. Diffusers
   2. Registers
   3. Grilles
   4. Door grilles
   5. Wind Driven Rain Louvers

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. Noise criteria shall be established by ASHRAE:
   1. The number of air devices shall be minimal.
   2. Provide enough air devices to maintain proper air distribution in the space.
   3. NC for Classrooms should not exceed 30.

B. Louvers shall meet AMCA 550 testing.

C. All air devices shall be extruded aluminum with white powder coat finish.

D. Utilize plastic supply air devices at the kitchen, lockers, showers, etc. where condensation can be an issue.

E. Utilize 24x24 face for lay-in ceilings and 12x12 face for hard ceilings. Airflow capacity may dictate face size in hard ceiling.

F. Provide volume damper in accessible location for each air device takeoff. If an air device and branch take off are in an inaccessible location provide opposed blade damper accessible from the face with removable key operation.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Price

B. Krueger

C. Titus

D. Metal Aire

E. Greenheck Corp.

F. Ruskin Manufacturing

2.02 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Type of device shall be coordinated with PROJECT COORDINATOR and DP (if applicable) on a project-by-project basis. The following are available options:
   1. Square, multi-louvered diffuser to discharge air in four-way pattern with sector baffles where indicated. Provide square to round neck adaptors where needed. Provide same appearance air devices regardless of neck size, unless project conditions dictate otherwise.
   2. Solid face panel with smooth edges and rounded off corners. Back cone shall be one piece, die-formed. Face panel shall be easily removable without special tools.
   3. Three-cone square panel, same appearance regardless of neck size.

2.03 CEILING AND WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.

B. Where filter grilles are specified, provide devices with hinge-tab mechanism and ¼ turn quick release fasteners with 1” thick filters.

2.04 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Egg crate with ½” x ½” x ½” aluminum grid core.

2.05 LOUVERS

A. Frame: 4 to 8 inch deep with minimum 0.095” nominal wall thickness, heavy gauge extruded aluminum frame. Louver depth shall be coordinated on a project-by-project basis.

B. Install per manufacturer’s installation instructions.

C. Provide aluminum bird screen in removable frame and aluminum insect screen in aluminum frame.

D. Louver must meet AMCA 540 testing, AMCA 550 testing, and have a Florida Product approval number.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section contains the requirements for variable air volume boxes.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 DESIGN CRITERIA

A. VAV boxes shall be located below the structure for proper service clearances.

B. Locate VAV boxes in corridors or adjacent spaces and not above classrooms.

C. Locate 24” minimum away from light fixtures.

D. Design for one VAV box per classroom.

E. Same exposure offices may share one VAV box. Corner offices and conference rooms shall have dedicated VAV boxes.

F. From branch take-off for VAV box use straight section of rigid duct minimum 4 feet long and sized 2” larger than VAV box connection, transition, then provide straight duct that is same size as the VAV box collar for 1.5 to 3.0 max duct diameters or as recommended by the manufacturer. Do not use flexible duct at the inlet to prevent turbulent flow and poor control performance.

G. Provide air terminals which have been tested and rated in accordance with ARI 880 standards.

H. Air Terminals shall met NFPA 90A and UL 181 and the Florida Building Code, latest ediition, Energy Conservation requirements.

I. Provide label on ceiling T-bar below VAV box for equipment location identification.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Price

B. Enviro-Tec

C. JCI

D. Titus Products Div.

E. Metal Aire

2.02 VAV BOXES WITH REHEAT

A. Provide double-wall boxes with minimum R-4 insulation value.

B. The air damper shall be gasketted and have a solid steel shaft, pivoted in self-lubricating bearings. In the full closed position, air leakage past the closed damper shall not exceed 1% of the nominal catalog rating at 4" w.g. inlet static pressure, when tested in accordance with ASHRAE 130.

C. The air flow sensor shall be located at the inlet of the VAV box. The sensor shall provide accuracy within 5% with a 90° sheet metal elbow directly at the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.

D. Controls enclosure boxes shall be provided for installation of controls on site.

E. Electric reheat is preferred. Where existing installations have heating hot water, a waiver from the PROJECT COORDINATOR may be offered on a project-by-project basis.

F. Electric-Resistance heating coils shall be provided with primary automatic and secondary manual, reset thermal cutouts. Elements shall be terminated in stainless-steel, machine-staked terminals secured with stainless-steel hardware. At a minimum, the following shall be provided:
   1. Access door interlocked disconnect switch.
   2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
   3. Airflow switches for proof of airflow.
   4. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
   5. Heaters 3 kW and smaller shall be single-stage. Use two-stage heaters for 4kw and larger heaters. SCR (Silicon Controlled Rectifier) control is preferred, if the cost impact is not significant. The DP shall verify and coordinate with the PROJECT COORDINATOR.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section contains the requirements for Direct Digital Controls.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 RESPONSIBILITY

A. At the time of substantial completion the controls CONTRACTOR shall coordinate with the DP scheduling of acceptance testing for controls verification.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. KMC, as provided by ABC - Automated Building Control Systems, Inc., 813-879-8222.

B. Johnson Controls Metasys, as provided by QBC, 813-885-5005.

C. Acceptable manufacturers' products must be compatible with the latest version of Niagara. The manufacturers must provide an open license to allow access for any Niagara engineering software tool such that any JACE panels and JACE Servers are capable of working with multiple vendor products.

2.02 QUALIFICATION OF BIDDERS

A. All bidders must be temperature control CONTRACTORS in the business of installing direct digital temperature controls with a minimum of fifteen years' experience of installing the specified manufacturer's control system. Minimum of five years of continuing contractual services for public or private school client is mandatory.

B. All bidders shall be factory owned branch office or factory authorized, with full time programmers, technicians and installers that will perform the work described on these construction documents. Sub-contracting with third party programmers or installers will not be acceptable.

C. All bidders shall have a local engineering and service office within 75 miles of the job site, be able to remotely access a system via the internet within two-hours from a service call and be on site within four hours from the initial service call if the remote access does not solve the issues generating the service call.

D. The bidders shall have a successful history in the design and installation of NiagaraAX Supervisor Integrated Automation Systems to provide real-time graphical information to

standard web-browsers, centralized data logging, archiving, alarming, trending, scheduling, system-wide database management, and integration of BACnet field level devices. The bidder must have a minimum of two Niagara certified technicians at the time of bid submittal.

2.03 COMMUNICATIONS NETWORKING, USER INTERFACE PROGRAMMING AND INTEGRATION

A. General:
   1. The Digital Network shall consist of a minimum of two tiers of communication.
      a. The lowest level tier shall be comprised entirely of cabling provided by the Controls CONTRACTOR which shall interconnect Controls CONTRACTOR provided digital network elements, independent of the PROJECT COORDINATOR'S intranet, this being the DDC trunk. This tier shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network. All devices shall utilize the ASHRAE/ANSI standard 135 "BACnet MS/TP" Protocol. All DDC Controllers shall be BACnet Testing Laboratories Listed or the manufacturer shall provide a letter indicating the date at which the proposed equipment was submitted to BTL for certification.
      b. The highest level tier shall be at the Ethernet level used for communications with other upper level devices, other Global Network Controllers on-site, the District's existing AX Supervisor server, other PC Workstations (either local or remote sites), and capable of access via standard web-browsers.
   2. There shall be a single point of interface between the Controls CONTRACTOR provided network and the site intranet.
   3. All building to building communications shall be accomplished using fiber optic interconnects.
      a. New Site or Major Construction Projects: The fiber optic cabling between buildings shall be provided by others under this contract and is not the responsibility of the Controls CONTRACTOR. The Controls CONTRACTOR shall coordinate their cabling plan requirements with the fiber systems provider prior to submittals and reflect the cabling plan in the shop drawings.
      b. Retrofit Stand-alone DDC Projects: Any existing fiber optic cabling that is to be reused by the controls CONTRACTOR shall be coordinated with the PROJECT COORDINATOR and implemented into the design documents. PCSB shall determine if the existing fiber optic cabling can be reused and it shall be noted on the DP'S Construction Documents whether to reuse existing or provide new fiber optic cabling in the bids. Any fiber runs found to be operationally deficient or not compliant with the manufacturer's requirements, shall be brought to the attention of the Engineer-of-Record via an RFI prior to or in concert with the submittal. The PROJECT COORDINATOR reserves the right to either add the replacement fiber to the contract or hire an
      independent third party to provide the same. All new fiber building-to-building fiber shown on the drawings shall be provided by the Controls CONTRACTOR as a part of the bid.

c. The Controls CONTRACTOR shall provide the media converters from copper to fiber and vice versa.

B. Network and User Interface Programming
1. Develop system graphics for all specified systems using animated objects to display all system variables. The DP shall coordinate with the PROJECT COORDINATOR for additional information.
   a. Provide a graphic Site plan with links to and from each building plan.
   b. Provide mobile graphics for all graphics. Chillers, AHUs and other major systems to include summary tables and schedules.
   c. Provide graphic floor plan screens for each building with links to each mechanical equipment room or zone controller. Display the space temperature point adjacent to each zone temperature sensor symbol.
   d. Provide graphic screens for the following:
      1) Chiller plant (pumping systems and chillers): system on/off, status, chiller evaporator barrel differential pressure (obtained from manufacturer's chiller controls), percent (%) capacity of each chiller, E/L temperatures each chiller, chilled water supply temperature, loop differential pressure, isolation valve command, plant flow gpm, loop chilled water supply temperature setpoint, loop chilled water return temperature, flow at each chiller flow meter and building flow meter, pump(s) status, on/off, speed of pump(s), bypass valve (where applicable).
      2) Air Handlers / Fan Coils: unit on/off, fan status, fan speed (%), Supply air temperature setpoint, supply airflow (where applicable), outside airflow (where applicable), outside air flow setpoint (where applicable), Outside air damper position (where applicable), return damper position (where applicable), filter status, Co_2 setpoint (where applicable), Co_2 level (ppm), supply static pressure and supply static pressure setpoint (where applicable), chilled water valve, return air dry bulb temperature and relative humidity, mixed air dry bulb temperature, coil leaving dry bulb temperature, unit discharge air dry bulb temperature and area served and associated exhaust fans status. Dampers and VFDs.
      3) VAV boxes: space temperature, space temperature setpoint, effective setpoint, heating setpoint deadband, cooling setpoint, heating setpoint, discharge air temperature (boxes with reheat), hot water valve (where applicable), damper position, airflow setpoint, actual airflow, minimum airflow and maximum airflow setpoints.
      4) Exhaust fans: status, on/off.
   e. Provide graphics for each AHU and Associated Zones on an actual building floor plan. Identify actual temperature at each zone and also AHU discharge temperature. Zones exceeding temperature setpoint shall have their temperature displayed in red and below setpoint in blue. See alarm table below.
2. All software shall be provided for the PROJECT COORDINATOR to make any changes to the system without Controls CONTRACTOR support (i.e. if the PROJECT COORDINATOR needs to change a graphic, provide the graphic software that generated the original). Programming software shall also be

embedded in Niagara controller to allow sequences to be edited or provide engineer tool software to allow PCSB to edit controller sequences and configurations.

3. The following are standard naming conventions for points in the programming:
   a. Typical Chiller Plant:

Chilled Water Plant (Variable Primary)	
Name	**Point**
Pump VFD Start/Stop (P-1, P-2)	P(X)-C
Pump VFD Status (P-1, P-2)	P(X)-S
Pump VFD Speed (P-1, P-2)	P(X)-O
Chiller Start/Stop (CH-1, CH-2)	CH(X)-C
Chiller Status (CH-1, CH-2)	CH(X)-S
Chiller Water Flow Sensor (CH-1, CH-2)	CHWF(X)-O
Chiller Amps (CH-1, CH-2)	CH(X)-A
Chiller 1 Compressor Enable Stage 1	CH1CMP1-C
Chiller 1 Compressor Enable Stage 2	CH1CMP2-C
Chiller 2 Compressor Enable Stage 1	CH2CMP1-C
Chiller 2 Compressor Enable Stage 2	CH2CMP2-C
Chiller Isolation Valve (CH-1, CH-2)	CHIV(X)-C
Chiller Differential Pressure (CH-1,CH-2)	CH(X)-DP
Chilled Water Bypass Valve	CHWBV-O
Chilled Water Loop Diff Pressure	CHW-DP
Outside Air Temperature	OA-T
Outside Air Humidity	OA-H
Chiller Supply Temperature (CH-1, CH-2)	CHS(X)-T
Chiller Return Temperature (CH-1, CH-2)	CHR(X)-T
Building Water Supply Temperature	BCHWS-T
Building Water ReturnTemperature	BCHWR-T
Chiller Water Flow (CH-1, CH-2)	CHW(X)-F
System Water Flow	CHP-F

b. Typical Chilled Water Variable Volume Air Handler:

CHW VAV Unit with VFD Controls/VAV boxes/Exhaust Fan	
Name	**Point**
VFD Start/Stop	SF-C
VFD Status	SF-S
VFD Speed	SF-O
Duct Static Pressure	DSP-P
Chilled Water Valve Modulate	CWV-O
Chilled Water Valve position	CWV-POS
CHW Cooling Coil Leaving Air Temp	CC-T
Outside Air Damper Modulate	OAD-O
Outside Air Damper Position	OAD-POS
Outside Air Volume	OA-F
Outside Air Temperature	OA-T
Outside Air Humidity	OA-H
Return Air Damper Modulate	RAD-O
Return Air Damper Position	RAD-POS
Return Air Humidity	RA-H
Discharge Air Temp	DA-T
Mixed Air Temperature	MX-T
Mixed Air Humidity	MX-H
Electric Heat Stage 1	HTG1-C
Electric Heat Stage 2	HTG2-C
Zone Temp	ZN_X-T
Zone Humidity	ZN_X-H
Zone Setpoint	ZN_X-SP
Zone Override	ZN_X-TOCC
VAV Box (X-X) Min. CFM	VV(X-X)MIN-F
VAV Box (X-X) Max. CFM	VV(X-X)MIN-F
VAV Box (X-X) Airflow	VV(X-X)-F
VAV Box (X-X) Elect Heat Staqe 1	VV(X-X)HTG1-C
VAV Box (X-X) Elect Heat Staqe 2	VV(X-X)HTG1-C
VAV Box (X-X) Air Valve Position	VV(X-X)D-POS
Exhaust Fan Start/Stop	EF-C
Exhaust Fan Status	EF-S

c. Typical DX Split Variable Volume Air Handler:

Split VAV DX Unit with VFD Controls/ Exhaust Fan	
Name	**Point**
VFD Start/Stop	SF-C
VFD Status	SF-S
VFD Speed	SF-O
Duct Static Pressure	DSP-P
Compressor 1 Enable	CLG1-C
Compressor 2 Enable	CLG2-C
DX Cooling Coil Leaving Air Temp	CC-T
Outside Air Damper Modulate	OAD-O
Outside Air Damper Position	OAD-POS
Outside Air Volume	OA-F
Outside Air Temperature	OA-T
Outside Air Humidity	OA-H
Return Air Damper Modulate	RAD-O
Return Air Damper Position	RAD-POS
Return Air Humidity	RA-H
Discharge Air Temp	DA-T
Electric Heat Stage 1	HTG1-C
Electric Heat Stage 2	HTG2-C
Zone Temp	ZN_X-T
Zone Humidity	ZN_X-H
Zone Setpoint	ZN_X-SP
Zone Override	ZN_X-TOCC
Exhaust Fan Start/Stop	EF-C
Exhaust Fan Status	EF-S

4. CONTRACTOR shall establish and store trend logs as well alarm notifications and logs. The DP shall coordinate with the PROJECT COORDINATOR for additional information.

See PCSB Alarm table below:

Minimum BAS alarms				
CV AHU/FCU				
Fan failure after 5 mins (adjustable)				
Discharge Air Temperature above 65F after 1 hour (adjustable)				
VAV AHU				
Fan failure to start after 5 mins (adjustable)				
Discharge Air Temperature above 65F after 1 hour (adjustable)				
Outside air damper not open/outside air cfm low				
High static pressure				
Static press below setpoint by -0.5 " after 1 hour (adjustable)				
Chiller Plant				
Chilled water supply 5 deg F(adjustuble) above setpoint for more than 1 hour (adjustable)				
Chilled water pump fails to start after 5 min (adjustable)				
Chilled water loop DP below setpoint for more than 1 hour (adjustable)				
Chiller alarm via chiller alarm contact after 10 min delay (adjustable)				
Fans				
Outside air fan or EF fails to start after 10 mins.(adjustable)				
Alarms will continue to be sent every 30 minutes until the alarm is acknowledged. The alarms will clear from the alarm console automatically once the alarm condition is no longer present. At no time will a “normal” or “ping” alarm be sent to the designated representatives (see below). Alarm generation forwarding shall be suspended during the hours of 9:00pm and 6:00am. Any alarms generated during this suspended time shall be saved and reported at the 6:00am hour.				
A text message/email shall also be forwarded to the “designated representatives” if any of the following occur:				
Name		Cell Number	Email Address	
Noel Palmer		863-287-1172	noel.palmer@polk-fl.net	
Jim Shulnes		863-412-5128	jim.shulnes@polk-fl.net	
Caroline Weaver		863-670-4697	caroline.weaver@polk-fl.net	
Steve Odom		863-521-7865	steven.odom@polk-fl.net	
Kitchen cooler/freezers (if monitored)				
Door remains open 20 min (adjustable)				
For sites with sensors in the kitchens cooler/freezer areas, if freezer unit's temperature reaches 16F for 30 minutes or less or if the cooler unit's temperature reaches 39F for 30 minutes.				
Send alarm to email dispatcher@polk-fl.net and cell phone 863-647-6445. 24 hrs a day/7 days a week.				
Graphics shall include a floorplan of the building(s) with color indication of the room's deviation from setpoint. The room color will be deep red when an area is 78°F or warmer. The room color will be deep blue when an area is 66°F or colder. Room colors will be white at the midpoint of 72°F. Flashing of the room colors will not occur.				

2.04 DDC EQUIPMENT

A. Master DDC Control Panel (MCP) JACE Panel:
   1. Provide an independent stand alone, microprocessor based control panel (MCP) for each facility, with embedded workbench and licenses for the field level controllers. The panel's license file shall be open to all Niagara engineering software tools from any vender controls manufacturers. The newest version of JACE panel shall be provided; its size shall be such that it covers all devices in the project's scope of work plus additional devices if the site is scheduled for future renovations.
   2. Acceptable manufacturers are Lynxspring, Tridium, JCI, Honeywell, Alerton.
   3. Each facility shall have a minimum of one MCP as a part of the communication network. The number of MCPs required is dependent on the type and quantity of devices installed. It is the responsibility of the CONTRACTOR to determine the quantity and type of devices and to properly furnish and install the correct number of MCP from the designed minimum shown. The CONTRACTOR shall confirm the designed network load and architecture with the capabilities of the selected MCP. If network communications issues arise as a result of a limited MCP resource count, the CONTRACTOR shall furnish, install, and implement additional MCPs.
   4. The operator shall communicate with the DDC system via the AX Supervisor (network server) and a standard internet web browser. Systems that require a PC Workstation with engineering software are not acceptable.
   5. The MCP shall communicate with Equipment Control Panels via BACnet MS/TP communications. All cabling shall be provided by the Controls CONTRACTOR.
   6. For campuses with multiple buildings, fiber optic cabling shall be used for the building-to-building trunk communication.
   7. In the event the Digital Network consists of multiple Master Control Panels, all points available on one MCP shall be accessible to all other MCPs.
   8. Provide all hardware and software necessary to allow remote communications to off-site locations connected to the PCSB intranet.
   9. Each MCP shall have a clock with battery back-up via integral rechargeable NiMH backup battery pack. Where there are multiple MCPs, their respective clocks shall be synchronized.
   10. The MCPs shall be located in areas of the building that are easily accessible for maintenance and repair. The CONTRACTOR shall coordinate the exact location of the MCPs with the Polk County Public Schools (PCS) controls department.
   11. The trend log, schedules and alarms shall be located and archived in the server based system. It is acceptable to store interim data in the MCP or the Equipment Control Panels and not the server for subsequent batch updating at the server provided the data is batch dumped to the server in a manner to minimize upper tier network traffic.
   12. The MCP shall be licensed for the Embedded Engineering Tool and WEB User Interface.

13. The MCP shall be provided with BACnet MS/TP licenses and all required drivers or modules to fully integrate the field level controllers into the MCP including configuration of all objects and properties and writing and editing of all control programs in field level controllers. Niagara module to allow modifications to sequences for field level controllers.
14. All New and Existing Network Controllers and Server equipment and software furnished by or integrated with this project shall be fully licensed to the PCSB. The licensing rights shall include the rights for the PROJECT COORDINATOR to authorize any CONTRACTOR of their choosing to perform work on the system. The installing CONTRACTOR shall hold no exclusive rights to the system as it pertains to software, hardware, system updates, system access, modifications, developed databases, etc.
15. All passwords shall remain factory default passwords for system access yielding full administration and configuration rights. These shall apply to work stations, servers, network controllers, configurable network electronics, controllers, system software / database and the like.
16. Each MCP panel shall be stand alone, mounted indoors, and in a standard NEMA 1 enclosure. The electrical power requirements shall be provided by the Controls CONTRACTOR. Coordinate circuits with the Division 16 CONTRACTOR. Provide dedicated power circuit(s) for controls. 110 VAC power should not be installed in the same raceway channels as 24 VAC. The 24 VAC power and the 110 VAC side of the panel shall be physically isolated and clearly labeled. Fuse all transformers. Control panels shall be clearly identified by labels (1” pop-riveted lettering). Provide and install as-built wiring diagrams to indicate the control points on all equipment. Provide laminated point lists in all MCP and equipment control panels.
17. The panel, when required, must functionally operate over a temperature range of 20 degrees F to 150 degrees F, and a humidity range of 0 - 95% non-condensing.
18. An uninterruptible power supply unit with minimum 15 minutes run time shall be provide to prevent controller shut down in case of temporary power loss. CONTRACTOR shall coordinate testing with PCSB.

B. Equipment Control Panels:
   1. The Manufacturer shall have multiple Equipment Control Panels (ECPs) specifically designed for HVAC applications. Panels for all major equipment shall be programmable and not configurable (with the exception of VAV controllers if no special sequence(s) is shown on the drawings), BacNet BTL certified. The ECPs shall be stand alone and shall interface with any user (the day-to-day occupants) devices (interface/room and/or zone sensors). The user interface device shall allow the operator to adjust set points, initiate push-button action overrides, and receive feedback of temperature and/or status.
      a. Input/Output (I/O) Interface:
         1) To gather sensor data and interface with controlled equipment, the ECPs shall use I/O types consistent with the application for which it is designed. This design shall allow different types of points using any of the following input/output options:

a) Input Options (universal; analog or digital): monitor the open/closed status of dry contacts, monitor analog values of voltages, current and resistance from temperature, pressure, relative humidity, CO2 sensors, etc.
b) Digital Outputs Options: control on/off, start/stop, open/close relays.
c) Analog Output Options: supply voltage or current outputs to controllers.

b. Universal Inputs (UI):
   1) The Equipment Control Panels shall accept isolated dry contact closures (either normally open or normally closed contacts).
   2) The Equipment Control Panels shall accept analog inputs (voltage, current, resistance). Minimum 12 bit A/D converters required.
   3) Analog inputs can be linear or non-linear. Points shall include an A/D converter and an analog power supply. All points shall be wired to the ECP device using #18 AWG twisted, shielded pair cables (Belden 8760 or equivalent) or larger or as recommended by the Controls Manufacturer.

c. Digital Outputs (DO): The digital outputs shall control on/off, start/stop relays which have low voltage coils. Dry contact or triac outputs are acceptable. Common ground outputs are acceptable. Provide override switches and LED status lamps on relay assembly.
   1) Enclosure Mounted: Use RIB model MUIS or equivalent.
   2) Field Mounted: Use RIB model UIS or equivalent.

d. Analog Outputs (AO): The analog output supplies voltage or current to the control devices (i.e., damper actuator). All output points to valves and dampers shall read as a percent open. Signal types shall include 4- 20 mA (into 1,000 Ohm load), resistance (up to 1,000 Ohms), and voltage (0-10 VDC). Provide a minimum 12-bit D/A converters.

2. Controller programming shall be fully configurable by the user. Controllers for major equipment that use only a “canned” program method will not be accepted. VAV Controllers can have “canned” programming if no special sequence of operations are shown on the drawings or noted elsewhere in this section or the VAV unit specifications.
3. Equipment Control Panels shall include but not be limited to: Chiller Control Panels, AHU Control Panels, split system AHU/CU, VAV Controllers, FCU Controllers, and EF Controllers.
4. DDC panels shall come with a minimum of six pre-existing available knockouts for ease of wiring during installation.
5. Control panels shall be clearly identified by permanent labels (one inch lettering), pop-rivet attached to the enclosure to match the tagging used on the record documents.
6. All controllers shall auto restart equipment upon loss of power after power is restored. The controller shall maintain the last user setpoints and not revert to factory settings after restart. The CONTRACTOR shall coordinate testing with PCSB.

2.05 PACKAGING AND ENVIRONMENT

A. Distributed Equipment Control Panel enclosures shall be locking type, metal cabinet, with common keying. All keys to subpanel enclosures shall match the master control panel key. The panels shall have a metal print pocket suitable for storing wiring, service and log information. Indoor panels shall be NEMA 1 hinged enclosures. Any panels in cooling tower or chemically treated areas shall be NEMA 4 stainless steel (fiberglass enclosures rated for outside applications are not acceptable). VAV box controllers shall have an enclosure by VAV box manufacturer.

B. The electrical requirements shall be identified and coordinated by the Controls CONTRACTOR. Any 110 VAC requirements are to be coordinated with Division 16 CONTRACTOR. Dedicated 110 VAC power circuits to each panel shall be provided by the Division 16 CONTRACTOR. 110 VAC power should not be installed in the same panel as 24 VAC. However, if 110 VAC power must be installed in the same panel with 24 VAC power due to design and/or system constraints, the 110 VAC side of the panel shall be physically isolated from the 24VAC side and clearly labeled. Fuse all transformers.

2.06 INTEGRATION OF FACTORY PROVIDED CONTROLLERS / DEVICES

A. Chillers (as applicable):
   1. The Mechanical CONTRACTOR in conjunction with the chiller manufacturer shall provide the Control CONTRACTOR with the proper protocol panel for chiller control integration (i.e. BACnet MS/TP). It shall be the Controls CONTRACTOR responsibility to clarify with the Mechanical CONTRACTOR that all hardware and software is to be provided on the chiller to interface with the BacNet DDC system. Protocol conversion devices must be provided as a part of the bid by the Controls CONTRACTOR, where needed.
      a. The Control CONTRACTOR shall provide communication wiring and conduit between the Chiller integration panel and the DDC system.
      b. Using the Chiller integration interface, the DDC Controller shall provide the following chiller data points (provide uniform syntax for all points) on the DDC system at a minimum:
         1) Water setpoint
         2) Water control point
         3) Entering chill water
         4) Leaving chill water
         5) Entering condenser water
         6) Leaving condenser water
         7) Evaporator refrigerant temperature
         8) Evaporator pressure
         9) Condenser refrigerant temperature
         10) Condenser pressure
         11) Discharge temperature
         12) Bearing temperature

13) Motor winding temperature
14) Oil sump temperature
15) Oil pressure transducer
16) Oil differential pressure
17) Base demand limit
18) Active demand limit
19) Line voltage percent
20) Line voltage actual
21) Compressor motor load
22) Compressor motor current
23) Compressor motor amps
24) Target Vane position
25) Actual van position
26) Total compressor starts
27) Starts in 12 hours
28) Compressor ontime
29) Service ontime
30) Compressor motor kW
31) Demand limit 4-20 mA
32) Temperature Reset 4-20 mA
33) CHWS sensor (each chiller)
34) CHWR sensor (each chiller)
35) Unoccupied/Occupied 0-no, 1-yes
36) Alarm state 0-normal, 1-alarm
37) Chiller start/stop 0-stop, 1-start
38) Hot gas bypass relay 0-off, 1-on
39) Chilled water pump 0-off, 1-on
40) Chilled water flow 0-off, 1-on
41) Condenser water pump 0-off, 1-on
42) Condenser water flow 0-off, 1-on
43) Compressor start relay 0-off, 1-on
44) Compressor start contact 0-off, 1-on
45) Compressor run contact 0-off, 1-on
46) Starter Fault contract 0-off, 1-on
47) Pressure trip contact 0-off, 1-on
48) Single cycle dropout 0-off, 1-on
49) Oil pump relay 0-off, 1-on
50) Oil heater relay 0-off, 1-on
51) Motor cooling relay 0-off, 1-on
52) Tower fan relay 0-off, 1-on
53) Compressor shunt trip relay 0-off, 1-on
54) Alarm relay 0-off, 1-on
55) Remote contacts input 0-off, 1-on

B. Power Monitors (as applicable):
   1. Veris E50H5A, BACnet MS/TP or E50C3 MODBUS

2. Provided by controls CONTRACTOR and installed by the electrical CONTRACTOR.

C. All points obtained from integration shall be writable and capable of being used in fully dynamic graphics with all the same features and functionally available to the system DDC points.

2.07 FIELD DEVICES

A. Automatic Control Dampers And Operators:
1. Automatic control dampers shall have interlocking blades and frames. Dampers shall be designed and constructed so that the blades, frames and linkage mechanism shall present a rigid assembly with free and easy action.
2. The submittal shall include leakage and flow characteristics and the reports shall be in accordance with AMCA standard 500-75.
3. When dampers are located at fan discharge, they shall be sized to operate properly without fluttering. Each automatic damper or section of damper, if too large for one motor, shall be operated by the required number of modulating motors. The motors shall be of the proper size required to operate the damper with uniform and gradual movement and shall return the damper to the same position for a given signal during an opening or closing movement of the damper. Damper operators shall be of the proportional type capable of accepting 0-10 volts or 4-20 ma control signal and 2-10 VDC feedback signal. The type of operator input signal shall be a function of the DDC control panel output.
4. Outdoor and Exhaust air damper operators shall include spring return with fail to the closed position, unless otherwise noted.
5. Approved damper manufacturers are: Greenheck, Ruskin, and Arrow.
6. The Control CONTRACTOR shall furnish all control dampers of the type and sizes indicated on the drawings for installation by the Sheet Metal subcontractor or the Mechanical CONTRACTOR.
7. Frames: Frames shall be 5” x 1” and manufactured with no less than .125” extruded aluminum hat channel with hat shaped mounting flanges on both sides. Each corner shall be reinforced with internal braces for maximum rigidity.
8. Damper Blades: Damper blades shall be airfoil type extruded aluminum. Each blade shall be a maximum of 6” with integral structural reinforcement for the full length of blade. Blades shall be equipped with low leakage flexible blade edge seals.
9. Blade Edge Seals: Damper blade edge seals shall be suitable for operation between 0°F and 200°F. The Control Manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers. Seals shall be mechanically locked in extended blade slots and easily replaceable in field.
10. Jamb Seals: Jamb seals shall be flexible stainless steel compression type to prevent leakage between blade and frame
11. Bearings: Bearings shall be non-corrosive molded synthetic. Axles shall be ½” plated steel hexagonal shaped to provide positive locking connection to blade.
12. Linkages: Linkages shall be concealed out of airstream within frame and easily accessible for maintenance.

13. Dampers shall be of the parallel blade design for two-position service and opposed blade design for modulating service.
14. Approved damper operator manufacturers shall be Belimo, KMC, and JCI.

B. Automatic Control Valves And Operators:
   1. Electronic Actuators
      a. Manufactured, brand labeled or distributed by Belimo.
      b. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
      c. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle; directly couple and mount to the valve bonnet stem; or ISO-style direct-coupled mounting pad.
      d. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
      e. Overload protected electronically throughout rotation.
      f. Fail Safe Operation: Mechanical fail safe shall incorporate a spring-return mechanism. Electronic fail safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors with a visual indication of the fail safe status on the actuator face with the power fail position field adjustable between 0 to 100% in 10^{o} increments, a 2 sec [0-10 sec field adjustable] operational delay, and capable of changing the fail-safe position through an integrated switch without removing the mounted actuator.
      g. Power Requirements: 24V
      h. Proportional Actuators shall be software configurable through an EEPROM without the use of actuator mounted switches**.** Programmable functions shall include a scalable operating range from 0.5 – 32.0 vdc with a 2.0 vdc (min) span; variable runtime; and data logging.
      i. Manual Override on all actuators.
      j. Actuators shall contain physical indication of actuator rotation position.
      k. Actuators shall be switch selectable for clockwise and counterclockwise rotation.
      l. Failsafe models shall be switch selectable for clockwise or counterclockwise rotation on failure of power.
      m. Actuators shall contain a manual stop that is installer adjustable over a range of 45 – 95 degrees of rotation.
      n. Housing: Minimum requirement NEMA type 2.
      o. Agency Listings: ISO 9001, cULus, CE or CSA.
      p. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
   2. Control Valves:
      a. Manufacturer:
         1) Manufactured, brand labeled or distributed by Belimo.

b. Control Valves:
   1) Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
   2) Sizing:
      a) Two-Position: Line size or size using a pressure differential of 1 psi.
      b) Two-Way Modulating: 5 psid or twice the load pressure drop, whichever is more.
   3) The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

c. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

d. Pressure Independent Control Valves:
   1) Pressure Independent Control Valves shall be used for all hot water and chilled water coil valves. Provide ePIV valves.
   2) NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.
   3) NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
   4) Accuracy: The control valves shall accurately control the flow from 0 to 100% rated flow with an operating pressure differential range of 5 to 50 PSI differential across the valve with a valve body flow accuracy of +/- 5% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
   5) Flow Characteristics: Equal percentage characteristic.
   6) All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
   7) The control valve shall require no maintenance and shall not include replaceable cartridges.
   8) NPS 1” and smaller pressure independent control valves may be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent, strainer/shut-off valve/drain with a P/T port – confirm details with details on the drawings prior to ordering. The return side shall contain a union fitting with a P/T port, pressure independent control valve, an integrated isolation ball valve/manual air vent with a P/T port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A flexible hose set shall be provided for each coil supply and return connection for all pipe packages; coordinate length requirements with installer.
   9) Actuators for 2-1/2” through 6” valves shall provide dynamic feedback to measure flow and verify performance.

10) Coordinate with Test & Balance CONTRACTOR and provide the manufacturer's published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

3. Valves for chiller, boiler, cooling tower, and other isolation applications:
   a. Butterfly type, 2-way or 3-way body pattern to meet the application
   b. "Bubble-tight" shut off for actuators up through 10" diameter 2-way applications and 8" 3-way applications. Valves shall be provided with EPDM rubber seals.
   c. Electronic capacitive or spring return failsafe (where applicable).
   d. Proportional (0 – 5VDC or 0 – 10VDC) position feedback indication of stroke position.
   e. Acceptable manufacturers shall be Belimo or Valve Solutions, Inc.
   f. Valve requirements larger than 8" 3-way or 10" 2-way size shall be provided by a vendor specializing in the design, fabrication, and delivery of such valves as submitted by the Controls CONTRACTOR.
   g. Provide NEMA 4 rated actuators for exterior applications.
4. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Valve bodies shall not be selected that are more than 1 line size smaller than pipe size.
5. Valves with sizes up to and including 2 inches shall be "screwed" configuration. Valves larger than 2" shall be provided with screwed to flange "companion flanges" if required by the mechanical CONTRACTOR. Ductile or cast iron valve bodies 2-1/2 inch and larger valves shall be "flanged" configuration.
6. Size all actuators in valve applications to provide shut off against rated system pressure + 25% over pressure.

C. Current Switches:
   1. Provide solid state current switches which when the current level sensed by the internal current transformer exceeds the pre-set trip point. Internal circuits are to be totally powered by induction from the line being monitored. Provide Form C relay contacts, while sensing both AC and DC circuits. Provide an LED light that shows: Rapid Flashing-switch is tripped, Slow Flashing-current is present but below the trip point, and No Flashing-current is either off or below the bottom of the range, and permits setting the trip point adjustment prior to system connection.
   2. Current switches shall be split core type and shall be non-adjustable.

D. Differential Pressure Switches:
   1. Differential pressure switches shall be furnished for status purposes for air and water applications. Provide single pole, double throw switch with fully adjustable differential pressure settings. The switch shall have a snap-acting, Form C contact rated for the application. Means to set and verify trip points shall be provided: visible setting or taps, or other mechanism. The switch contact shall be rated for 5 amps at 120 volts, as a minimum. Units shall be selected for ranges consistent with the application and shall be submitted for the DP and PROJECT COORDINATOR'S approval.

a. Acceptable Manufacturers: Dwyer and Cleveland.

E. Electronic Temperature Sensors:
1. Temperature sensors shall be thermistor or 100 Ohm Nickel/Platinum with plus/minus 0.5° F for temperature range of 35°F to 160°F. Sensors shall be calibrated to less than or equal to a 1/2 degree F resolution for the specific application.
2. Provide twisted pair lead wires and shield for input circuit or as otherwise more restrictive requirements set by the manufacturer.
3. Insertion elements for liquids shall be brass separable sockets (i.e., thermowells) with minimum insertion length of 2-1/2 inches (60 mm).
4. Provide outside air sensors with watertight inlet fittings, shielded from direct rays of the sun. Mount on the north side of the facility.
5. The temperature sensors shall be field verified by the Installing CONTRACTOR.
6. Wall mounted sensor shall be mounted at 5'–6" above finished floor in an area where free air current is not constricted or blocked. Final location shall be approved by the PROJECT COORDINATOR and the DP prior to installation. The sensor shall allow the operator to adjust set points, initiate push-button action overrides, and receive feedback of temperature and/or status. Wall mounted sensors in common areas (i.e. Corridors, Cafeteria, Auditorium, Gymnasium, etc.) shall be a flush mounted, stainless steel wall sensors.
7. Sensor elements shall be applicable for the medium being sensed (i.e., room elements, well mounted elements, duct mounted elements and outdoor mounted elements). Range shall be from 0 to 150ºF.
8. Strap on sensors shall not be used unless specifically required.

F. Electronic Static Pressure Sensors:
1. Static pressure sensors shall be differential pressure sensors, with the "high" output sensing the duct pressure and the "low" input sensing atmospheric pressure.
2. The range for the static pressure sensor shall be matched to the static pressure of the system being sensed, 0 to 0.5 inches, 0 to 2 inches, 0 to 5 inches, or 0 to 10 inches.
3. Accuracy shall be plus or minus 2% of the full range being sensed.
4. Duct Static Pressure sensors shall be provided with vinyl tubing from the sensing point to the associated AHU room. The pressure to current transducer shall be located in the AHU room.

G. Humidity Sensor/Transmitter:
1. Provide relative humidity sensor/transmitter where shown on the control drawings. Sensor and transmitter shall have:
   a. System Accuracy: ±2% RH @ 25°C from 20% to 95% RH.
   b. Output Signal: Two-wire, 4-20 mA linear (or 0 – 10 VDC) proportional to 5% to 95% RH.
2. The transmitter power shall be compatible with and powered by the low voltage power supplied by this CONTRACTOR.

H. Carbon Dioxide Gas Sensor/Transmitter:
   1. Duct or Space application, 5 year calibration accuracy, 0 – 2000ppm range +/- 5% accuracy over range. Optional LCD display, integral self-calibration algorithm. Meets ventilation requirements of ASHRAE standard 62-1999. Programmable altitude correction in 500' elevation increments. Repeatability +/- 20ppm, stability +/- 20ppm typical with 5 year re-calibration interval.

I. Outside Air Monitor And Control:
   1. Each VAV air handling unit shall have an airflow control station capable of performing constant volume control of outside air without loss of required outside air at part load.
   2. Each airflow monitor and control station shall be complete with a velocity transmitter and air volume flow rate control.
   3. All velocity to CFM calculations shall be done in the DDC system.
   4. Where called for on the AHU specifications, the AHU manufacturer shall provide the sensing station and matched velocity to signal conversion. Linearization and conversion from velocity to CFM shall be done in the DDC system.
   5. When using a duct mounted air monitoring station, the sensing station shall be the responsibility of the Controls CONTRACTOR. The velocity signal shall be brought into the DDC system. Linearization and conversion to CFM shall be accomplished in the DDC system.
   6. Controls CONTRACTOR to notify Division 15 CONTRACTOR of any outside air openings that result in bypassing the air monitor sensor.

J. Airflow Measuring Stations (Duct Airflow Measuring Device):
   1. Provide airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics. Approved manufacturers / model: EBTRON, Inc. Model GTx116-PC or equal, contingent on compliance with requirements below.
      a. Fan inlet measurement devices shall not be used unless indicated on drawings or schedules.
      b. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
      c. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.
      d. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.

e. Sensor Density Requirements:
   1) The number of individual sensor nodes provided for each rectangular location shall be as follows:

Duct or Plenum Area (ft^2)	Total # Nodes / Location
<= 1	1 or 2
>1 to < 4	4
4 to < 8	6
8 to < 12	8
12 to < 16	12
>= 16	16

   2) The number of individual sensor nodes provided for each round or oval duct location shall be approximately the same number required for rectangular locations of a comparable size or shall be published in documentation by the manufacturer.
   3) Submittal documents shall include schedules indicating the number of sensors per location, the duct area and the equivalent density (quantity of sensing nodes per area) for approval.

f. Thermistors shall be potted in an engineered thermoplastic assembly using water-proof, marine epoxy and shall not be damaged by moisture or direct contact with water.
g. Signal processing circuitry located on the surface of or within the sensor probe is not acceptable.
h. Each sensing node shall be individually wind tunnel calibrated at 16 points to NIST traceable airflow standards.
i. Each sensing node shall provide sensors calibrated at no less than 3 points to NIST traceable temperature standards.
j. All internal wiring between thermistors and probe connecting cables shall be Kynar jacketed.
k. The ATMD manufacturer shall provide UL Listed, FEP jacketed, plenum rated cable(s) between sensor probes and the remote transmitter.

2. Measurement Performance:
   a. The ATMD shall be capable of measuring airflow rates over the full calibrated range of 0 to 5,000 FPM (25.4 m/s) between -20°F to 160°F (-28.9°C to 71°C).
   b. Each sensing node shall have an airflow accuracy of ± 2% of reading throughout the entire calibrated operating range.
   c. Each sensing node shall have a temperature accuracy of ± 0.14°F (0.08°C) over the entire operating temperature range of -20°F to 160°F (-28.9°C to 71°C).
   d. Overall device accuracy shall be ± 3% of reading throughout the entire calibrated operating range, or better.
3. Integral Transmitter:
   a. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown- outs.
   b. The total power requirement for the ATMD shall not exceed 22 V-A.

c. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
d. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
e. The environmental operating temperature limits for the transmitter shall be 0°F to 120°F (-28.8°C to 48.8°C).
f. All electrical plugs, receptacles and circuit board interconnects shall be gold plated.

4. Interface to BAS:
   a. Each transmitter shall be capable of providing one of the following interface card options:
      1) Dual analog output/RS-485 card. Each analog output shall be isolated from the main circuit board and shall be field configurable as 0-5VDC, 0-10VDC or 4-20mA. One analog output shall provide a linear output for average air velocity or volumetric airflow rate (FPM or CFM). A second analog output shall provide a linear output for average or velocity weighted average temperature. The second analog output shall also be capable of providing an airflow alarm signal in lieu of temperature. The RS-485 output shall be field configurable as BACnet MS/TP. The RS-485 output shall contain onboard switch selectable termination settings of None, End of Line or Fail-safe Bias. The RS-485 baud rate shall be selectable via the transmitter setup menus for values of 9600, 19200, 38400 and 76800 baud. BACnet products shall be BTL listed. BACnet device instance number or Modbus address shall be selectable via the transmitter setup menus. Individual sensor node airflow and temperature values shall be available over BACnet and Modbus. ATMD status shall be available over BACnet and Modbus.
      2) Dual analog output/Ethernet card. Each analog output shall be isolated from the main circuit board and shall be field configurable as 0-5VDC, 0-10VDC or 4-20mA. One analog output shall provide a linear output for average air velocity or volumetric airflow rate (FPM or CFM). A second analog output shall provide a linear output for average or velocity weighted average temperature. The second analog output shall also be capable of providing an airflow alarm signal in lieu of temperature. The 10/100-Base-T Ethernet output shall be field configurable as BACnet-Ethernet, BACnet-IP, TCP/IP or Modbus TCP. BACnet device instance number shall be selectable via the transmitter setup menus. Individual sensor node airflow and temperature values shall be available over BACnet and Modbus. ATMD status shall be available over BACnet and Modbus.

3) BACnet ARCnet card. Provide a single RS-485 BACnet Arcnet output. The RS-485 output shall contain onboard switch selectable termination settings of None, End of Line or Fail-safe Bias. Individual sensor node airflow and temperature values shall be available over BACnet. ATMD status shall also be available over BACnet.

5. Operating Features:
   a. An Altitude Correction Adjustment feature shall be provided in firmware for field usage when desired.
   b. The transmitter shall allow real-time duct traverse measurements by inclusion of an expansion port capable of providing an infra-red interface to manually download airflow and temperature data or for uploading transmitter configuration data using a handheld PDA or compatible IR reader.
   c. The transmitter shall include an Enhanced Output Integration filter and buffer capability for control situations requiring signal stabilization.
   d. Low Airflow/High Airflow and Deadband Alarm functions shall be available on models where compliance with LEED Outdoor Air Delivery Monitoring prerequisite, credits and ASHRAE Standard 189.1 are required.
   e. A Low-Limit Cutoff feature shall be available to enhance control performance in specific situations when needed.
   f. An integral Field Calibration Wizard shall be available on combination analog/network output products to automate and simplify field setup for output adjustments when desired.
6. Listings and Certifications:
   a. The ATMD shall be UL 873 listed.
   b. The ATMD RS-485 models shall be BTL Listed.
7. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans, prior to fabrication and installation.
   a. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

K. Water Flow Switches
   1. Provide pressure-flow switches of the solid state type with appropriate scale range and differential adjustment for service indicated.
      a. Acceptable Manufacturers: IFM.
      b. Coordinate with chiller manufacturer for specific requirements of water flow switches.

L. Water Flow Meter:
   1. Furnish an insertion Electromagnetic Flow Meter complete with hot tap full port ball valve and installation hardware necessary to enable insertion and removal of the meter without system shutdown. Paddle type flow meters are not acceptable. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually calibrated and tagged accordingly against the manufacturers primary standards which must be accurate to within 0.1% traceable to the U.S. National Institute of Standards and Technology (NIST). A

certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1.

2. The sensor shall have integral analog outputs of 2 to 10VDC, 0-5VDC or 4-20 mA current output for connection to the DDC system. An elevated zero shall be required to facilitate troubleshooting. All outputs shall be linear with flow and require no computational linearization. Bi-directional flow meters shall include a binary (digital) dry contact output for flow direction. Refer to the drawings for meter type required.
3. An optional display shall be provided for network interface and local / remote indication of flow rate and total, if required by the drawings.
4. Approved product / manufacturer: F-3500 by Onicon, with minimum two years manufacturer warranty.
5. Where project requirements dictate it, provide an ONICON System-10 Series BTU meter. The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be either BACnet® MS/TP, BACnet/IP or via individual analog and pulse outputs. The System-10 shall be provided with temperature sensors that are bath-calibrated and matched for the specific application, temperature thermowells and all required installation hardware. Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).

M. Refrigeration Leak Detectors:
   1. When the Mechanical CONTRACTOR provides refrigerant leak detectors, the Controls CONTRACTOR shall be responsible to interface the detector with the DDC system.
   2. Provide a minimum of three remote sensor inputs from the detector. The input point data may be with discrete points or obtained through integration. Points to be provided by the Controls CONTRACTOR are:
      a. Refrigerant PPM (AI),
      b. High PPM (BI),
      c. ASHRAE-15 Ventilation Fan Status (BI).
   3. The Controls CONTRACTOR shall inspect the chiller plant installation(s) at the site and notify the Engineer-of-Record if no refrigerant monitor exists or if it is non-operational.
   4. No emergency ventilation sequences shall be in the DDC system. This shall remain a stand-alone 110VAC relay logic system for integrity of operation. Where points are called for above, they shall be monitored only and the Controls CONTRACTOR shall provide devices, as needed, to interface with the DDC system for maintainability and alarming. DDC system resets or control overrides for the emergency ventilation system shall not be permitted on this Life Safety sub-system.

N. Low Temperature Limit Sensors:
   1. Provide low temperature protection thermostats of manual-reset type with sensing elements 8' or 20' in length. Provide thermostat designed to operate in response to coldest 1' length of sensing element, regardless of temperature at other parts of

element. Support element properly to cover entire duct width. Provide separate thermostats for each 25 sq.ft. of coil face area or fraction thereof.
2. Sensors shall be provided by Controls CONTRACTOR, if not provided as an integral part of the AHU. Control circuit shall be 110 VAC and shall be provided by the Controls CONTRACTOR.
3. If called for on the documents, provide a BI to an auxiliary contact.

O. Control Wiring:
1. All conductors shall be of stranded copper wire.
2. All PVC/EMT/rigid steel conduit and outlet boxes shall conform to the requirements specified under Division 16, Electrical.
3. All cabling (routed in conduit or not) shall be plenum smoke rated.
4. All wiring cables shall have 600 volt insulation and shall be provided with a bound stripping string to facilitate preparing wire terminations.
5. Conduit fittings shall be steel compression or set screw type.
6. All wiring in exposed areas, in outdoor soffits and wall cavities shall be in conduit.

P. Variable Frequency Drive (VFD) Motor Speed Controller (Refer to Drawings for Voltage, Size, and Location found on Pump and/or Air Handling Unit Equipment Schedules):
1. Variable Frequency Drives and other Adjustable Speed Drives/Controllers are to be provided by others and interfaced by this Controls CONTRACTOR into the DDC system;
2. Provide the following minimum hard-wired discrete inputs/outputs between the drives and the DDC system:
   a. AO to control drive speed;
   b. AI reference to monitor actual drive speed;
   c. BO to activate the drive;
   d. BI for drive failure alarm (drive fault).
3. All new VFDs shall be provided with a communication interface. If specifically called for on the plans, existing VFDs shall be provided with a communications integration interface between the drive and DDC system. This requirement shall not replace the requirement for the listed minimum discrete I/O points.

Q. Room/Zone sensor (Thermostat):
1. Provide UL listed thermostat with digital room temperature display, humidity sensing with no display, limited user override, and surface mounting base. Thermostat to be locked out with the exception of allowing user to adjust room temperature set-point range from 72º to 76ºF.

R. Exhaust Fan Temperature Thermostats (Non-Conditioned Electrical Rooms, Stand-Alone Split System Applications, As Required):
1. Provide UL listed, two position (i.e., On/Off) room thermostat with bimetallic sensing element, set point thumb wheel dial, room temperature indicator, surface mounting base, and hard plastic cover plate.

S. Building Pressure Sensors:
   1. Provide indoor pressure sensor with LCD display. Sensor shall be BAPI-Box with attached static tube and bottom port connections.
   2. Provide outdoor static pressure pickup port with exterior polytubing installed in EMT conduit. Pressure pickup port shall be BAPI Model ZPS-ACC10.

2.08 MONITORING

A. All points associated with HVAC equipment as shown on the drawings and in this section.

B. Provide temperature sensors for monitoring dry storage area, kitchen cooler/freezers, MDF / IDF rooms.

C. Power metering (chilled water plant, main electrical panel, kitchen electrical panel(s), etc.) Refer to section 16010. Coordinate with the PROJECT Coordinator.

PART 3 – SEQUENCE OF OPERATIONS.

3.01 VARIABLE VOLUME AIR HANDLER

A. Occupied mode
   1. The fan operates based on a time schedule. During normal business hours (6:00 am to 6:00 pm - adjustable), the fan shall run continuously. During nights, weekends and holidays (as programmed at the front end computer or remotely), the fan shall run intermittently on a call for cooling.

B. Return and outside air damper: the outside air (OA) damper shall be closed whenever the air handler's fan is off, the unit operates in morning pre-heat or pre-cool sequences or the unit operates in night and weekend mode. The return air damper shall be open at all times.
   1. During normal business hours, the return air damper and outside air damper shall be modulated as needed to maintain a constant volume of outside air as measured by the airflow monitor.
   2. The CONTRACTOR shall provide an adjustable mechanical stop on the return damper to limit the damper's closing to 30% free area (adjustable).

C. VFD control: during occupied hours the DDC controls shall monitor the air volume demand of all VAV/FPB boxes and modulate the fan speed per the sequence below. The air handlers shall have a low limit airflow (percentage to be established with air handler's manufacturer and shall be adjustable) and monitored through their associated VFD's. The frequency of the VFD needed to achieve low limit airflow shall be coordinated between the controls and the test and balance CONTRACTORs.
   1. When any VAV damper is more than 85% (adjustable) open, the supply fan discharge duct static pressure setpoint shall be reset upward by 0.1 in w.c. (adjustable), at a frequency of 5 minutes (adjustable), until no damper is more than

85% open or the static pressure setpoint has reset upward to the system maximum duct static pressure setpoint or the air handler's variable frequency drive is at the maximum speed setting.

2. When all VAV dampers are less than 65% (adjustable) open, the supply fan discharge duct static pressure setpoint shall be reset downward by 0.1 in W.C. (adjustable), at a frequency of 5 minutes (adjustable), until at least one damper is more than 65% open or the static pressure setpoint has reset downward to the system minimum duct static pressure setpoint or the AHU variable-frequency drive is at the minimum speed setting.
3. The BMS shall have the capability to allow the operator to exclude "problem" zones that should not be considered when determining the optimized setpoint.
4. The BMS shall also read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
5. The BMS shall display to the user on the floor plan graphics, the VAV box tag that serves the critical zone (that is, the zone with the most wide-open VAV damper), along with supply fan discharge static pressure. This information shall update dynamically as the location of the critical zone changes based on building load, and duct static pressure setpoint optimization control.

D. High static pressure: each air handler shall have a high static pressure alarm (1.75" w.g., adjustable), as sensed by its associated duct mounted static pressure sensor and will limit the high duct static pressure setpoint (2.0" w.g., adjustable) through the VFD's.

E. Chilled Water Valve:
   1. The modulating valve shall operate in response to the supply air discharge temperature sensor. The initial setpoint is 55ºF (adjustable). The supply air temperature (sat) shall be reset from 55 towards 60ºF, in one degree increments (adjustable), at 15 minutes intervals (adjustable), as long as the return air temperature drops and remains below 74ºF for a minimum 30 minutes (adjustable).
   2. The return air relative humidity shall be continuously monitored and associated dewpoint temperature calculated, as long as the return air dewpoint temperature is at or below 57ºF, the sat shall continue to be reset upwards at 15 minutes intervals (adjustable) should the dewpoint temperature exceed 57ºF for more than 15 minutes (adjustable), the sat shall be reset to 55ºF. if the return air dewpoint temperature continues to be above 57ºF after operating at 55ºF sat for another 30 minutes (adjustable), the sat shall be reset towards 52ºF, in one degree increments (adjustable) at 15 minutes intervals (adjustable) until the dewpoint reaches 55ºF (adjustable).

F. Cooling / heating / pre-cool / pre-heat:
   1. Cooling shall be enabled when the outdoor air temperature is at or above 50ºF (adjustable). The operator shall be able to toggle the heat on all boxes on/off with one switch on the main system graphics. The operator shall also have the option to manually choose which heaters to be locked out on an individual basis.

2. Heating shall be enabled when the outdoor air temperature is below 50ºF (adjustable). When in heating mode, the chillers and pumps shall be off, and all chilled water valves shall be closed.
3. The programming shall include a morning pre-cool / pre-heat sequence. At 5:30 am (adjustable) the system shall be energized with all outside air dampers closed and all exhaust fans off in either cooling or heating mode, based on outside air conditions. The pre-cool / pre-heat mode shall end once the space temperature conditions are at cooling / heating setpoints (74ºF / 68ºF) or the building is scheduled for normal occupancy.
4. The operator shall have the option to turn on / off the pre-cool / pre-heat sequence at the front end computer (locally and remotely) on the main system graphics screen.

G. VAV boxes:
1. During occupied cooling mode the VAV box damper shall modulate the damper between minimum cooling and maximum cooling positions as needed to maintain the occupied cooling setpoint (74°F, adjustable). If the room temperature falls below heating setpoint, the damper shall open to heating minimum airflow and the electric heat shall be energized.
2. During unoccupied mode the VAV boxes shall be modulated fully open to protect against duct over pressurization at start-up.
3. Setpoints shall be adjustable at local space temperature sensor adjustable between 72º-76ºF.

H. Safeties (for all AHU's):
1. The following safeties shall shut down the unit upon alarm condition:
   a. Fire alarm condition.
   b. The high discharge static pressure switch trips (w/manual reset) and alarm is generated.
   c. Whenever the cooling coil discharge air temperature reaches 37ºF (adjustable). An alarm shall be generated.

I. Shutdown:
1. The following occurs when the AHU fan is stopped either by safeties as noted above or if in its unoccupied mode:
   a. The OA damper closed and the return air damper opens.
   b. The main chilled water valve closes to it coil and the electric heat is cycled off.
   c. The interlocked exhaust fans per its schedule are stopped.
   d. If the supply static pressure fails to increase above a minimum setpoint, the DDC system uses this to confirm the fan is in the desired state and generates an alarm if the status deviates for the DDC start/stop control.

3.02 CONSTANT VOLUME AIR HANDLER

A. Occupied mode: The fan operates based on a time schedule. During normal business hours (7:00 am to 6:00 pm - adjustable), the fan shall run continuously. During nights,

weekends and holidays (as programmed at the front end computer or remotely), the fan shall run intermittently on a call for cooling.

B. Outside air damper: Shall be closed whenever the air handler's fan is off, the unit operates in morning pre-heat or pre-cool sequences or the unit operates in night and weekend mode. During normal business hours, the outside air damper shall be open.

C. Chilled water valve: The modulating valve shall operate in response to the supply air discharge temperature sensor. The initial setpoint is 55ºF (adjustable).

D. Cooling / heating / pre-cool / pre-heat:
   1. Cooling shall be enabled when the outdoor air temperature is at or above 50ºF (adjustable). When in cooling mode, the electric heat shall be locked out. The operator shall be able to toggle the heat on all boxes on/off with one switch on the main system graphics. The operator shall also have the option to manually choose which heaters to be locked out on an individual basis.
   2. Heating shall be enabled when the outdoor air temperature is below 50ºF (adjustable). When in heating mode, the chillers and pumps shall be off, and all chilled water valves shall be closed.
   3. The programming shall include a morning pre-cool / pre-heat sequence. At 5:30 am (adjustable) the system shall be energized with all outside air dampers closed and all exhaust fans off in either cooling or heating mode, based on outside air conditions. The pre-cool / pre-heat mode shall end once the space temperature conditions are at cooling / heating setpoints (74ºF / 68ºF) or the building is scheduled for normal occupancy.
   4. The operator shall have the option to turn on / off the pre-cool / pre-heat sequence at the front end computer (locally and remotely) on the main system graphics screen.

E. Safeties (for all AHU's):
   1. The following safeties shall shut down the unit upon alarm condition:
      a. Fire alarm condition.
      b. Whenever the cooling coil discharge air temperature reaches 37ºF (adjustable). An alarm shall be generated.

F. Shutdown: The following occurs when the AHU fan is stopped either by safeties as noted above or if in its unoccupied mode:
   1. The OA damper is closed.
   2. The main chilled water valve closes to its coil and the electric heat is cycled off.
   3. The interlocked exhaust fans are stopped.

3.03 AIR COOLED CHILLER PLANT VARIABLE PRIMARY FLOW PUMPING.

A. Start-up operation:
   1. Upon a call for cooling by any of the scheduled air handlers, the lead chiller shall have its chilled water control/isolation valve opened and after a short time delay, when the control/isolation valve has fully opened, the lead chilled water pump shall

start. Upon proof of flow through the chiller's differential pressure switch, the chiller start sequence shall begin. The chiller shall operate via its independent control panel to maintain the design leaving chilled water temperature (42ºF remotely adjustable at the front end).

2. The chilled water pump's speed shall be controlled to maintain differential pressure setpoint as sensed by a differential pressure sensor located 2/3 the distance on the longest main piping run (not a branch line) in the chilled water system.
3. Once activated, the pumps' variable frequency drives shall modulate as needed to maintain constant pipe differential pressure. The setpoint of the differential pressure sensor shall be field coordinated between the test and balance and controls subcontractors. The bms shall continuously calculate and reset the differential pressure setpoint based on actual position of all chilled water valves in the system, such that none of the valves is less than 90% open in order to achieve discharge air temperature at its associated air handler.
4. The operator shall have the option to turn on / off the differential pressure calculation routine at the front end computer (locally and remotely) on the main system graphics screen and use a fixed input.

B. Starting the second chiller:
   1. When the %RLA of the lead chiller reaches 100% (adjustable) or the plant leaving CHW temperature exceeds setpoint for a period of 30 minutes (adjustable), the controls shall initiate the lag chiller start sequence. After a short time delay, the lag CHW pump shall slowly ramp up and simultaneously, the lag chiller isolation valve shall slowly open. The lag chiller shall start upon proof of flow via the chilled water differential pressure switches and maintain its 42º (adjustable) setpoint temperature. As the lag CHW pump ramps up, the lead pump's speed shall be reduced inversely to operate in unison to maintain the differential pressure setpoint.

C. Full load operation:
   1. During full load operation, both chillers shall operate via their independent control panels to maintain the leaving chilled water setpoint temperature. Both chiller isolation/control valves shall be fully open. The differential pressure sensors across each chiller shall provide a signal to the DDC control system so that minimum chilled water flow is maintained through each chiller.
   2. Chilled Water Reset (Required for CH-1 and CH-2)—The EMS shall allow reset of the chilled water supply temperature setpoint based on return chilled water, ambient temperature, or any other monitored point such as selected space temperature. The reset parameters shall be user selectable.

D. Transition operation - stopping a chiller:
   1. When both chillers operating %RLA reaches 40% or less for 30 consecutive minutes (adjustable), or the CHW return temperature falls below setpoint by ½ the design delta t (49º adjustable) for more than 30 minutes (adjustable), the controls shall shut down the lag chiller. After a short time delay, the CHW isolation valve shall slowly close. The lag pump shall slowly ramp down to a stop, while the lead pump is inversely-proportional ramped up.

E. Bypass-valve operation (variable primary flow only:
   1. The bypass valve shall remain closed under all operating conditions except when the building flow requirements are less than the minimum flow rate of one chiller. As flow approaches the minimum evaporator flow rate (note: adjustable according to actual installed chiller and the evaporator flow/pressure map provided by the chiller manufacturer and coded into the control algorithm by the controls CONTRACTOR, the bypass control valve shall slowly open to maintain minimum flow through the operating chiller as sensed by the chiller's differential pressure sensor across the chiller evaporator barrel.
   2. The controls CONTRACTOR shall coordinate with the mechanical CONTRACTOR to obtain the minimum and maximum flow ranges for the installed chiller to implement into the chiller plant control algorithm.

F. Chiller status report:
   1. Provide an operating status report for each chiller. The report(s) shall provide the present status for the following information to provide the operator with critical chiller operating data. As a minimum, provide:
      a. Compressor on/off status
      b. Compressor starts/run hours
      c. Compressor phase 1/2/3 percent RLA - separate for each compressor
      d. Compressor current draw - RLA percent
      e. Active chiller diagnostics or alarms
      f. Leaving chilled water temperature
      g. Entering chilled water temperature
      h. Chilled water setpoint
      i. Refrigerant temperature evaporator/condenser
      j. Operating mode

G. Freeze protection:
   1. The chilled water pumps shall start and all CHW controls valves shall be commanded open to circulate water when the ambient temperature reaches 37º (adjustable) as sensed by the OA temperature sensor.

H. Cooling mode:
   1. Cooling mode shall be defined based on outdoor temperature conditions - 50ºF (adjustable). Chillers shall be locked out below this temperature.
   2. Stage the air handler's startup and shut down schedules to avoid rapid water flow changes through the chiller.

END OF SECTION

PART 1 – GENERAL

1.01 EXTENT OF SECTION

A. This section includes the requirements for:
   1. Testing, adjusting, and balancing of air systems.
   2. Testing, adjusting, and balancing of hydronic systems.
   3. Measurement of final operating condition of HVAC systems.

B. The intent of the PCSB STANDARDS is for the DESIGN PROFESSIONAL (DP) to comply with the minimum general project requirements and the specific project specifications shall be generated and provided by the DP.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 sections, apply to work of this section.

B. Related Sections:
   1. Other Division 15 sections specify balancing devices and their installation, and materials and installations of mechanical systems.
   2. Individual Division 15 system sections specify leak testing requirements and procedures.

C. Approved Test and Balance CONTRACTORS:
   1. Southern Independent Testing Agency
   2. The Phoenix Agency
   3. Pro-Tech Diversified Services

1.03 SUMMARY

A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

B. Test, adjust, and balance the following mechanical systems:
   1. Supply air systems.
   2. Return air systems.
   3. Exhaust air systems.
   4. Hydronic systems.
   5. Verify temperature control system operation.

C. Test systems for proper sound and vibration levels.

D. This section does not include:
   1. Testing boilers and pressure vessels for compliance with safety codes.

2. Specifications for materials for patching mechanical systems.
3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
4. Requirements and procedures for piping system leakage tests.

1.04 DEFINITIONS

A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
   1. The balance of air and water distribution.
   2. Adjustment of total system to provide design quantities.
   3. Electrical measurement.
   4. Verification of performance of all equipment and automatic controls.
   5. Sound and vibration measurement.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the system's major or entire fluid flow.

I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.

J. Branch Main: Duct or pipe serving a single terminal.

1.05 SUMBITTALS

A. Engineer and Technicians Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures and the technicians proposed to perform the procedures meet the qualifications specified below.

B. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
   1. Pre-Construction Plan Check: The CONTRACTOR shall review the plans and/or visit the site prior to the start of construction of the project (new or existing systems). Provide a plan review (in writing) within thirty (30) days upon receipt of contract to include any recommended modifications or changes to the system(s), and how they should be made to allow the most effective total system balance. Provide one (1) copy to the CONTRACTOR and two (2) copies to the DP.

C. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

D. Submit agenda of test procedures for each system, describing balancing standards for the testing, balancing and commissioning of the air conditioning, heating and ventilating systems for the approval of the DP. This agenda shall include all forms for each system and component, with specified data from the project plans and specifications included on the forms.

E. Make inspections of the systems during construction for proper installation of balancing devices and general construction as related to the test and balance work. The number of inspections will vary with size and complexity of the project, but a minimum of two inspections are required: one at 50% completion of ductwork installation, the second at 80% completion of ductwork installation. A written report of each job visit shall be sent to the DP with copies to the PROJECT COORDINATOR and CONTRACTOR.

F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the test and balance engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.

G. Draft Reports: Within one week of completion of testing, adjusting, and balancing procedures, submit draft report directly to the DP on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit two (2) complete sets of draft reports. Only 1 complete set of draft reports will be returned.
   1. Immediately notify the DP in writing of any system(s) that do not provide the design quantities as scheduled and specified.
   2. Coordinate with the Installing CONTRACTOR, those items or systems that requires corrective action to meet design performance, in a timely manner. Retest after corrections have been accomplished.

H. Final Report: Upon verification and approval of draft reports, prepare final reports, type written and organized and formatted as specified below. Submit four (4) complete sets of

final reports.

I. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
   1. General Information and Summary
   2. Air Systems
   3. Hydronic Systems
   4. Temperature Control Systems
   5. Special Systems
   6. Sound and Vibration Systems

J. Report Contents: Provide the following minimum information, forms and data:
   1. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, the CONTRACTOR, PROJECT COORDINATOR, and DP. Include addresses and contact names and telephone numbers. Also, include a certification sheet containing the seal and name, address telephone number and signature of the certified test and balance engineer. Include in the division a listing of the instrumentation used for the procedures along with the proof of calibration.
   2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each time of equipment and system to accompany each respective report form.

K. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.06 SCHEDULING

A. Agency Qualifications:
   1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
   2. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one professional engineer, registered in the state in which the services are to be performed, certified as a test and balance engineer.

B. Codes and Standards:
   1. AABC: "National Standards for Total System Balance"
   2. ASHRAE: "ASHRAE Handbook", HVAC Applications Volume, Chapter 37, "Testing, Adjusting, and Balancing".

C. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the DP and representatives of installers of the mechanical systems The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

D. Compliance with the latest approved edition of the Florida Building Code – Energy Efficiency Chapter.

1.07 PROJECT CONDITIONS:

A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.08 SEQUENCING AND SCHEDULING

A. Test ducts for leakage prior to the application of insulation or concealment in soffits or chases.

B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

C. Test, adjust, and balance air conditioning systems during summer season and heating systems during winter season, within 5°F dry bulb temperature of design condition. Take final temperature readings during seasonal operation.

D. minimum of one after-occupancy inspection shall be made within 90 days of the final test and balance. At this time, any minor adjustments shall be made for occupant comfort. Major problems, which will require major readjustments, shall be addressed to the DP prior to any readjustments. Any alterations to the final test and balance report shall be transmitted as a revised report to the PROJECT COORDINATOR/DP.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 DUCT LEAKAGE TEST

A. The mechanical CONTRACTOR shall make all the supply return, outside air, and exhaust duct systems operationally air-tight, to be nor more than 2% leakage for duct systems rated at 2" w.c. pressure class, and 1% leakage for systems exceeding 2" w.c. pressure class. Leakage test to be performed by the Mechanical CONTRACTOR with all air device openings and fan connections sealed airtight. Test the systems prior to applying any insulation or concealing in soffits or chases. The ductwork shall be tested after the installation of the take-offs for VAV boxes (variable air volume systems) or air

devices (for constant volume systems) on supply ductwork and return / exhaust air devices for the return and exhaust ductwork. All take-offs shall be installed prior to the duct leakage test. Use a portable fan capable of producing a static pressure equal or greater than the duct test pressure. Fan shall have a flow measuring assembly consisting of a straight section of duct with an orifice plate, pressure taps, and a calibrated performance curve for determining leakage rates. The leakage test shall be witnessed by the Test & Balance CONTRACTOR. It is the Mechanical CONTRACTOR'S responsibility to schedule the test; a minimum of five business days' notice shall be given to the Test & Balance CONTRACTOR.

A. Test each section equal to the external static pressure indicated for that fan or air handler with the portable fan assembly. After the fan achieves that steady state design pressure, record the air flow quantity across the orifice and the percent of design air flow. If the test fails, the CONTRACTOR shall reseal and retest at no additional cost to the contract.

B. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.

C. Submit duct leakage reports to the DP for review and approval.

3.02 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps:
   1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
   2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust), and temperature control diagrams.
   3. Compare design to installed equipment and field installations.
   4. Walk the system from the central equipment to terminal units to determine variations of installation from design.
   5. Check filters for cleanliness.
   6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
   7. Prepare report test sheets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check.
   8. Determine best locations in main and branch ductwork for most accurate duct traverses.
   9. Place outlet dampers in the full open position.
   10. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
   11. Lubricate all motors and bearings.
   12. Check fan belt tension.
   13. Check fan rotation.

3.03 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

A. Before operating the system perform these steps:
   1. Open valves to full open position. Close coil bypass valves. Set modulating valve to full coil flow.
   2. Remove and clean all strainers.
   3. Examine hydronic systems and determine if water has been treated and cleaned.
   4. Check pump rotation.
   5. Clean and set automatic fill valves for required system pressure.
   6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
   7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
   8. Set temperature controls so all coils are calling for full flow.
   9. Check operation of automatic bypass valves.
   10. Check and set operating temperatures of chillers/boilers to design requirements.
   11. Lubricate all motors and bearings.

3.04 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readiness until 2 consecutive identical values are obtained.

G. Take all readings with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuating readings.

I. Take measurements in the system where best suited to the task.

3.05 RESPONSIBILITIES OF THE TEST AND BALANCE CONTRACTOR

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

B. Air Balance:
   1. Record minimum data required by AABC forms.
   2. Test and adjust fan rpm to design requirements.
   3. Test and record motor full load amperage/voltage and operating amperage/voltage.
   4. Make pitot tube traverse of main supply, return OA and exhaust ducts and obtain design cfm at fans (where possible).
   5. Test and adjust system for deigned cfm recirculated air.
   6. Test and adjust system for design cfm outside air.
   7. Test and record system static pressure profile.
   8. Adjust all main supply and return air ducts to proper design cfm.
   9. Adjust all zones to proper design cfm, supply, return and exhaust.
   10. Adjust all VV terminals to design minimum, maximum and/or heat cfm and record controller setpoint.
   11. Provide suggestion/corrective measures pertaining to performance related issues.
   12. Test and adjust each diffuser, grille, and register to within % of design requirements.
   13. Each grille, diffuser and register shall be identified as to the location, area and system.
   14. Test and adjust fan to within 100%-105% of design.
   15. Test and adjust kitchen hoods and fume hoods. On hoods with multiple section, adjust the exhaust / make-up airflow of each section to airflows indicated by the kitchen consultant.
   16. Test and adjust kitchen hoods and fume hoods. On hoods with multiple section, adjust the exhaust / make-up airflow of each section to airflows indicated by the kitchen consultant.
   17. Test and adjust kitchen hoods and fume hoods. On hoods with multiple section, adjust the exhaust / make-up airflow of each section to airflows indicated by the kitchen consultant.
       a. Provide all readings at all filters sections (velocity, airflow) and indicate corrections factor used for determining final airflow.

C. Chilled Water/Hot Water Balance:
   1. Set pumps to 100%-105% of design flow.
   2. Adjust flow of water through chillers/boilers.
   3. Check leaving water temperatures and return water temperature through chillers/boilers. Reset to correct design temperatures.
   4. Check water temperature at inlet side of coils.
   5. Proceed to balance each water coil. Upon completion of flow readings and adjustments at coils, mark all settings and record data.
   6. After adjustments to coils are made, recheck settings at the pumps and chillers/boilers, and readjust if required.
   7. All flow devices to be balanced to within ±5% of design.

D. Record and check the following items at each cooling/heating element:
   1. Test and record entering air temperature (DB heating and cooling).
   2. Test and record entering air temperatures (WB cooling).
   3. Test and record leaving air temperatures (DB heating and cooling).
   4. Test and record leaving air temperatures (WB cooling).

5. Entering and leaving water temperature.
6. Pressure drop of each coil or vessel.
7. Calculate gpm.
8. Calculate total cooling and heating coil capacities.
9. If test conditions are not within design tolerance, then convert the test conditions to design conditions, or retest when conditions are closer to design (e.g. opposite season test).

E. Record and check the following items at each motor:
   1. Amperage; provide readings for each phase on 3-phase motors.
   2. Voltage; provide readings for each phase on 3-phase motors.
   3. Power factor; coordinate with the Electrical CONTRACTOR, as necessary.
   4. Motor efficiency; coordinate with the motor supplier and provide accurate data.

F. Check all controls for proper calibrations and list all controls requiring adjustment by control installers. A software point-by-point checkout and test, along with verification forms, will be required.

G. Test each sequence of operation for all systems to verify proper operation. Include description of operating in report.

H. Record the dry bulb temperature and relative humidity in each.

I. Deficiencies: All deficiencies shall be noted by the agency in a field report and submitted to the CONTRACTOR and DP on a daily basis.

J. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

K. Patch insulation, ductwork, and housings, using materials identical to those removed.

L. Seal ducts and piping, and test for and repair leaks.

M. Seal insulation to re-establish integrity of the vapor barrier.

N. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

O. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.06 RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

A. The Mechanical CONTRACTOR shall complete the installation and start all HVAC systems to insure they are working properly, and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC systems.

B. Air Distribution Systems:
   1. Verify installation for conformity to design.
   2. Insure that all supply, return, and exhaust ducts are installed in such a manner that maximum allowable leakage rates as required by specifications are not exceeded. Notify the Test and Balance CONTRACTOR and the PROJECT COORDINATOR when duct system is ready for leak testing. Provide test openings and temporary end caps or otherwise seal off ends of ductwork to permit leakage testing prior to installation of air devices.
   3. Insure that all volume, splitter, extractor, and fire dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return, relief and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
   4. Verify that all supply, return, exhaust, and transfer grilles, registers, diffusers, and high-pressure terminal units are installed and operational.
   5. Insure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.
   6. Insure that all fans (supply, return, relief, and exhaust) are operating and free of vibrations. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protections shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.
   7. Make any necessary changes to the sheaves, belts, and dampers, as required by the balancing agency, at no additional cost to the PROJECT COORDINATOR.
   8. Install clean filters.

C. Water Circulating Systems:
   1. Verify installation for conformity to design.
   2. Check all pumps to verify pump alignment and rotation.
   3. Insure that systems are clean, with the proper strainer screens installed for normal operation.
   4. Check all pump motors for current and voltage, to insure that motors do not exceed nameplate rating.
   5. Provide overload protection of proper size and rating.
   6. Insure that all water circulating systems shall be full and free of air; that expansion tanks are set for proper water level; and that all air vents were installed at high point of systems and are operating.
   7. Check and set operating temperatures of heat exchangers to design requirements.

3.07 RESPONSIBILITIES OF THE TEMPERATURE CONTROL CONTRACTOR

A. The Temperature Control CONTRACTOR shall complete the installation of the temperature control system, and operate and test all controls systems to insure they are functioning properly as designed. The Temperature Control CONTRACTOR shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze stats.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.
3. Calibrate room thermostats after installation, and before the thermostat control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
4. The Temperature Control CONTRACTOR shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to; computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.

3.08 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by, the referenced standards and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

C. A copy of the Test and Balance Report, which is reviewed and accepted by the Engineer of Record, shall be made available at the final AHCA inspection.

END OF SECTION