SECTION 25 1100 – BMS BASIC MATERIALS, INTERFACE DEVICES AND SENSORS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Maintain Section format, including the UH master spec designation and version date in the center columns of the header and footer. Complete the header and footer with Project information.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction.*

1.02 SUMMARY

A. Wiring.

B. Control Valves and Actuators.

C. Control Dampers and Actuators.

D. Control Panels.

E. Sensors.

F. Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

G. Transducers.

H. Current Switches.

I. Nameplates.

J. Testing Equipment.

K. Refer to Section 25 0000 “Building Management Systems (BMS) General” for general requirements.

L. Refer to Division 23 Sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not Work of this Section.

M. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections.

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.
4. All other necessary wiring for a fully complete and functional control system as specified.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the BMS Provider who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the BMS Provider who will be fully responsible for the proper operation of the damper.

C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BMS Provider who will be fully responsible for the proper installation and application.

D. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120 volt (V) control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. BMS Provider shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide electronic, pneumatic, and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2.02 MATERIALS AND EQUIPMENT

Pneumatic controls should only be used on retrofit projects. Remove paragraphs associated with pneumatics if not applicable to project.

A. Control Air Supply: Contractor may reuse existing control air in buildings where pneumatic controls will be replaced. Contractor shall install air dryers and air filters so that all controllers and new pneumatic devices receive a clean and dry air supply.

1. The control air filters shall remove oil and solid particles from the compressed air. Provide a pre-filter and a final filter.
2. The pre-filter shall be rated for 100 percent removal of all solids 1 micron and larger, 100 percent removal of liquid water, and 70 percent removal of oil aerosols with 2000 ppm maximum inlet liquid loading.
3. The final filter shall be rated for 100 percent removal of liquid water and solids larger than 0.03 micron; 99.999 percent removal of oil aerosols with 100 ppm maximum inlet liquid loading.
4. Filters shall include replaceable filter element, differential pressure gauge, and automatic liquid drain trap. Filters shall be selected for a maximum pressure drop of 2 psig at compressor capacity. Filter bodies shall be rated for 225 psig or greater operating pressure. Transparent acrylic tube housings shall be protected by a perforated steel safety shield.
5. Filters shall be Hankison, DelTech, Wilkerson, or Arrow Pneumatics. Substitutions shall be allowed per Division 01. Furnish one (1) spare filter element per filter.

THE FOLLOWING IS A COSTLY REQUIREMENT THAT WILL SIGNIFICANTLY INCREASE THE INSTALLATION COST. ENGINEER SHALL USE CAUTION IN SPECIFYING THIS REQUIREMENT AND SHALL CONSULT WITH

OWNER PRIOR TO SPECIFYING THIS REQUIREMENT.

6. Provide a PRV, oil filter and air filter combination assembly at each end use pneumatic device so that all pneumatic devices receive a clean and dry air supply.

    a. The control air filters shall remove oil and solid particles from the compressed air.
    b. Particulate filters shall be rated for 100 percent removal of all solids 5 micron and larger, 100 percent removal of liquid water, and removal of oil aerosols 0.01 microns and larger. Filters shall include replaceable filter element and automatic piston drain.
    c. Filters shall be selected for a maximum pressure drop of 5 psig at device capacity. Filter bodies shall be rated for 150 psig or greater operating pressure. Provide ¼- inch ports. Provide relief valve set at 30 psig.
    d. Filter/PRV's selection based on Wilkerson, Model Combination C08. Substitutions shall be allowed per Division 01.

EDIT THE FOLLOWING TO SUIT THE PROJECT. ENGINEER SHALL CONSULT WITH OWNER PRIOR TO SPECIFYING THE DRYERS.

7. For systems where no pneumatic tubing is subject to temperatures below 40 degrees F and without refrigerated dryers, provide an air-cooled refrigerated dryer with flow capacity at 100 degrees F, 100 psig saturated entering air, and 40 degrees F leaving dewpoint equal to or exceeding air compressor capacity.

    a. Refrigerated dryer shall be a single package unit with all necessary piping, refrigerant, controls, wiring and accessories.
    b. Dryer shall include refrigeration system, on/off switch, inlet air pressure gauge, and water separator with automatic drain. Refrigerant shall be R-134a. System shall be labeled by CSA or UL.
    c. Manufacturer shall be Hankison, Wilkerson, DelTech, Ingersol-Rand Tide/Aire, McKee or Arrow Pneumatics.

8. For systems with outdoor pneumatic components or components otherwise exposed to ambient conditions, provide a desiccant-type heatless self-regenerative air dryer for piping providing air supply to these components.

    a. Dryer capacity shall exceed connected load, plus a 30 percent allowance for expansion with inlet conditions of 100 degrees F, saturated air at 100 psig, and outlet conditions of minus 40 degrees F dewpoint.
    b. Dryer maximum air pressure drop at rated flow shall not exceed 5 psig. Required air flow for regeneration shall not exceed 20 percent of dryer output capacity.
    c. Dryer shall include two desiccant towers, piping, changeover valves, exhaust silencers, controls and wiring.
    d. Desiccant towers shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, and shall be ASME stamped for 125 psig

working pressure and fitted with suitable relief valves if tower physical size places tower within the scope of the Code where stamp is required.

e. Desiccant dryers shall be as manufactured by Hankison, Deltech, Arrow Pneumatics, Ingersol-Rand or Zurn.

9. Main Air Piping (between the compressors and the field control panels): Hard drawn copper tubing, ASTM B 88, Type L.

10. Branch Air Piping (to include main air between field control panels and field devices: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead-free composition solder.

11. Branch Air Piping Termination And Tubing Within Control Panels: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737. Use compression or push-on brass fittings.

B. Instrument Pipe and Tube:

1. Hydronic and Instruments:

a. Connection to Main Piping: Provide ½ inch minimum size threadolet, ½ inch x 2 inch brass nipple, and ½ inch ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.

b. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼ inch FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.

c. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.

d. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing outside diameter size shall be not less than the larger of ¼ inch or the instrument connection size.

e. Rigid Piping for Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.

2. Low Pressure Air Instrument Sensing Lines

a. Connections: Use suitable bulkhead type fitting and static sensing tip for static

pressure connections. Adapt tubing to instrument connection.

b. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

3. Secondary LAN Communication Wiring and BMS low voltage wiring/cables: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26. Wiring/cables shall be provided in a customized color jacketing material. Color coding shall be green or orange. Material and labeling shall be as specified in Section 27 0553 “Identification for Communication Systems”. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals outside the UNIVERSITY OF HOUSTON IT infrastructure. (e.g., operator workstations, printers, and modems).
4. Local Supervisory LAN: For any portions of this network required under this Section of the Specification, Contractor shall comply with Division 27 Communications specifications. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
5. Secondary Controller LANs: Communication wiring shall be individually 100 percent shielded pairs per manufacturer’s recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.

    a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in wet locations. Direct burial wiring without a raceway is prohibited.

6. BMS low voltage wiring/cables: All cables shall have legible printed sleeve identification labels at each device and the panel termination.

    a. Labels shall be Brady PermaSleeve TM, part number - "BPSPT-187-175-WT” or equivalent approved by Owner per Division 01 Substitution Procedures.

    b. Each label shall be identified with the entire BMS point name utilized in the BMS database and the point address.

C. Signal Wiring: Contractor shall run all signal wiring in accordance with the latest edition of the National Electrical Code and Division 26.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100 percent shielded pair, minimum 18-gage wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.

    a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in

wet locations. Direct burial wiring without a raceway is prohibited.

2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

D. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with the latest edition of the National Electrical Code and Division 26.

1. Low voltage control wiring shall be minimum 18-gage, twisted pair, 100 percent shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices and shall be separated from any wiring above thirty (30) volts.

a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in wet locations. Direct burial wiring without a raceway is prohibited.

Coordinate with UH project manager on mounting height of Control Panels.

E. Control Panels: Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels [**60 inches – confirm with Owner**][**60 inches**] above finished floor or roof. Refer to Figures A and B at end of section.

1. Interior: Fabricate panels of 16-gage furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color. Panel / enclosure shall be sized to provide adequate mounting space for all components plus a minimum of 25% spare backplane capacity. All components shall have a minimum of 2 inch clearance from the four sides of the panel unless factory wired and designed otherwise. No flush-mounted panels.
2. Exterior: 16-gage 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.
3. Provide UL-listed cabinets for use with line voltage devices.
4. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip. Wire nuts are not acceptable in exposed area of panel. High and low voltage cables shall be isolated from each other.
5. All gauges and control components shall be identified by means of nameplates or Owner-approved equivalent.
6. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. (Electrical wireway shall be located underneath panel to run wire, allowing wiring to enter from below.)
7. Provide a 6 inch x 6 inch minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the bottom of the panel with close nipples of

sufficient size for additional 50 percent wiring and tubing capacity. Wireways shall not be less than 24 inches in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.

8. Complete wiring and tubing termination drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.

2.03 STANDARD SERVICE CONTROL VALVES

A. Contractor shall be responsible for control valve sizing based on criteria provided in Contract Documents.

B. General:

1. Provide factory fabricated control valves of type, body material and pressure class indicated.
2. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system.
3. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.
4. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application.
5. Minimum close-off rating shall be as scheduled and adequate for each application and shall generally be considered at dead head rating of the pump.

Design engineer shall provide a control valve schedule for the BMS Contractor to use as a basis for sizing control valves.

C. Selection Criteria:

1. Control valves shall be suitable for operation at maximum system design pressure over temperature range encountered.
2. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
3. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
4. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
5. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
6. Modulating butterfly valves shall have equal percentage flow-throttling characteristics.
7. Fail positions unless otherwise indicated on drawings:

Edit to suit project.

a. Chilled Water: Last position.
b. Condenser Water: Last position.
c. [**Heating**][**Hot**] Water: Last position.
d. [**Insert any other systems here.**]

8. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
9. Selection shall consider viscosity, flashing, and cavitation corrections.
10. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
11. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
12. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of [**5 psid**][**7 psid**][**xx psid**] at design flow unless otherwise indicated.
13. Two-position control valves shall be line size unless otherwise indicated.
14. In water systems, use ball-style control valves for two-position control for valves NPS 2 and smaller; and butterfly style for valves larger than NPS 2.

D. Globe Valve for Steam Service:

1. Valve Sizing: Where valve size is not specifically indicated in the Contract Documents, size modulating valves for applications of 15 psig or less for 80 percent of inlet gauge pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42 percent of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.

    a. Working Temperature: 250 degrees F minimum for saturated steam applications of 15 psig or less; 366 degrees F minimum for saturated steam applications of greater than 15 psig up to 150 psig.

3. Body: Bronze, screwed, 250 psig steam working pressure for ½ inch to 2 inch; Cast iron, flanged, 100 psig steam working pressure for 2-1/2 inches and larger for applications of 50 psig or less.
4. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
5. Packing: Spring Loaded Teflon.
6. Disc: Replaceable composition or stainless steel filled PTFE.
7. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:

    a. Belimo
    b. Honeywell

E. Butterfly Type:

1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal.
3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft.
4. Bearings: Bronze or stainless steel.
5. Shaft: 416 stainless steel.
6. Cold Service Pressure: 175 psi.
7. Close Off: Bubble-tight shutoff to 150 psi.
8. Operation: Valve and actuator operation shall be smooth, both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Owner.
9. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:

    a. Keystone.
    b. Jamesbury.
    c. Bray.
    d. Dezurik.

F. Ball Type:

1. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. Seat: Reinforced Teflon.
3. Ball: Stainless steel.
4. Port: Standard or 'V' style.
5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. Flow Characteristic: Equal Percentage.
7. Cold Service Pressure: 600 psi WOG.
8. Steam working Pressure: 150 psi.
9. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:

    a. Honeywell
    b. Belimo
    c. Spiraxsarco
    d. Jordan
    e. Apollo.

G. Segmented or Characterized Ball Type:

1. Body: Carbon steel (ASTM 216), one-piece design with wafer style ends.
2. Seat: Reinforced Teflon (PTFE).
3. Ball: Stainless steel ASTM A351.
4. Port: Segmented design with equal-percentage characteristic.
5. Stem: Stainless steel.
6. Cold Service Pressure: 200 psi WOG.

7. Cavitation Trim: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
8. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:

    a. Jamesbury R-Series.
    b. Fisher.
    c. Belimo.

2.04 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. Provide parallel or opposed blade dampers as recommended by manufacturer's sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 6 inches wg.:

1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 16-gage minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts, 14 gage minimum extrusion thickness.
4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
5. Jamb Seals: Stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than 0.1 percent based on approach velocity of 4000 fpm and 1 inches wg.
10. Maximum Pressure Differential: 6 inches wg.
11. Temperature Limits: -40 to 200 degrees F.
12. Where opening size is larger than 48 inches wide or 72 inches high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12 inches wg.:

1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 12-gage minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 3/4 inch shafts with set screws.
4. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
5. Linkage: 10-gage minimum thickness galvanized steel clevis type crank arms, 3/16 inch x ¾ inch minimum thickness tie rods.
6. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm and 1 inches wg differential pressure.
8. Maximum Pressure Differential: 12 inches wg.
9. Temperature Limits: -40 to 300 degrees F.
10. Where opening size is larger than 48 inches wide or 72 inches high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

D. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm, differential pressure not greater than 4 inches wg.:

1. Performance: Test in accordance with AMCA 500.
2. Frames: Rolled 12 gage steel strip for sizes 6 inch and smaller, rolled 14 gage steel channel for larger sizes, galvanized or aluminum finish.
3. Blades: Steel construction, 12 gage minimum thickness for dampers less than 18 inches in size, 10 gage minimum thickness for larger dampers.
4. Blade Seals: Full circumference neoprene.
5. Shaft: ½ inch diameter zinc or cadmium plated steel.
6. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm and 1 inches wg differential pressure.
8. Maximum Pressure Differential: 4 inches wg.
9. Temperature Limits: -40 to 300 degrees F.

E. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm, differential pressure not greater than 6 inches wg.:

1. Performance: Test in accordance with AMCA 500.
2. Frames: Rolled 10-gage steel channel for sizes 48 inch and smaller, rolled 3/16 inch

thick steel channel for larger sizes, galvanized or aluminum finish.

3. Blades: Steel construction, 10-gage minimum thickness for dampers not greater than 48 inches in size, ¼ inch minimum thickness for larger dampers.
4. Blade stops: ½ inch x ¼ inch full circumference steel bar.
5. Blade Seals: Full circumference neoprene.
6. Shaft: Zinc or cadmium plated steel, angle reinforcing as necessary.
7. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
8. Leakage: Less than 0.4 percent based on approach velocity of 4000 fpm and 1 inches wg differential pressure.
9. Maximum Pressure Differential: 6 inches wg.
10. Temperature Limits: -40 to 250 degrees F.

2.05 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Actuators:

1. Ambient Operating Temperature Limits: -10 to 150 degrees F.

Keep paragraph below for projects using pneumatic actuators.

2. Pneumatic Actuators: Provide heavy-duty actuators with stroke indication and spring return. Actuator shall consist of steel or aluminum cylinder and pistons. Housing shall be protected both internally and externally with corrosion resistant coating. Provide position feedback positive positioners with adjustable start point and operating range. Positive positioners shall be provided on all pneumatic valves larger than 1 inch.
3. Two Position Electric Actuators: Single direction, spring return or reversing type. Provide end switches.
4. Electronic Actuators: Provide actuators that are capable of stopping at all points across full range and starting in either direction from any point in range (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than [**30**][**60**][**90**] seconds. Stroke time for exhaust, supply and make-up fans shall be [**30**][**60**][**90**] seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. [**Parallel actuators on a single valve are not allowed.][Where two actuators are required in parallel or in sequence provide an auxiliary actuator driver.]** Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated.

a. Close-Off Pressure: Provide the minimum torque required, and spring return

for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and plus 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.

b. Subject to compliance with requirements, approved manufacturers are as follows:

1) Siemens.
2) Belimo.
3) Honeywell (with approval by BMS)

Keep paragraph below for projects using pneumatic actuators.

5. Pneumatic Single- and Double-Acting Cylinder Type:

a. Air Cylinder: Shall consist of steel or aluminum cylinder, dual pistons, double rack and pinion gearing mechanism. Housing shall be protected both internally and externally with corrosion resistant coating. Actuator shall be equipped with piston guide rods or similar mechanism so that seals are not loaded as linear bearings. Single acting units shall have multiple symmetrically arranged springs to apply equal force to piston. Cylinder shall be configurable for direction of fail-safe mode in the field. Actuators shall be spring return type for failsafe positioning.

b. Position Indication: Provide extended shaft position indicator that is removable for manual override of valve.

c. Two-Position Actuators: Provide appropriate three-way or four-way solenoid valve mounted on the actuator. Solenoid valve electrical enclosure shall meet NEMA 4 requirements. Provide actuator with position switches where required.

d. Modulating Actuators: Provide a rotary electronic positioner designed to accept 4- 20 mA, 0-10 Vdc, 2-10 Vdc, or 135 Ohm potentiometer and operate integral 3-way or 4-way solenoid valve to position valve rotation angle as sensed by integral position feedback device to match signal input. Enclosure shall meet NEMA-4 requirements. Actuator linearity and resolution shall be 0.5 percent of span. Hysteresis and deadband shall be adjustable. Provide accessory mechanical or proximity type position switches and position transmitters where required. Actuators shall be spring return type for failsafe positioning. Provide an enclosure heater for positioners located outside of buildings. [Engineer to coordinate power and electrical wiring for heater.]

2.06 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as

recommended by field device manufacturers and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to ensure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with 'two-wire' type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.07 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3 degrees F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25 degrees F over five (5) years.

ENGINEER SHALL CAREFULLY SPECIFY OTHER APPLICATIONS WHERE MATCHED SENSORS ARE REQUIRED FOR THE SPECIFIC PROJECT.

B. Matched Sensors: The following applications shall require matched sensors:

1. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5 percent of span plus 0.1 degrees C.
2. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air set point to maintain a leaving heating coil temperature. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5 percent of span plus 0.1 degrees C.

ENGINEER MUST DESIGNATE WHERE VARIOUS AMENITIES TO ROOM SENSORS ARE REQUIRED. THE FOLLOWING ASSUMES THAT THIS WILL BE INDICATED ON THE CONTRACT DOCUMENTS. OTHERWISE

ENGINEER MUST ADD THE CLARIFICATION BELOW. EDIT/DELETE THE FOLLOWING TO SUIT THE SYSTEMS AS APPLICABLE.

THESE ARE SENSORS FOR STANDARD CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

C. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting, unless noted otherwise. Provide insulated base. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.6°F accuracy at calibration point.
2. Provide set point adjustment where indicated. The set point adjustment shall be a warmer/cooler indication that shall be scalable via the BMS.
3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure.
4. Provide current temperature indication via an LCD or LED readout, where noted.

THESE ARE SENSORS FOR CRITICAL CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

D. Critical Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, +/- 0.1 degrees C measured at 0 degrees C.
2. Provide set point adjustment where indicated. The set point adjustment shall be a warmer/cooler indication that shall be scalable via the BMS.
3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure
4. Provide current temperature indication via an LCD or LED readout, where noted.
5. Where the lab is a strong acid use, CRTSs shall be adequate for acidic environment.

THESE ARE SENSORS FOR STANDARD CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

E. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3 degrees F accuracy at calibration point

THESE ARE SENSORS FOR CRITICAL CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

F. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature

range as required for resolution indicated. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, +/- 0.1 degrees C measured at 0 degrees C.

EDIT THE FOLLOWING AVERAGING LENGTH PER SQUARE FOOT BASED ON HOW HOMOGENEOUS THE AIR TEMPERATURE WILL BE AT THE INSTALLED LOCATION. FOR INSTANCE, A PREHEAT SENSOR OF A MIXED AIR PLENUM WILL REQUIRE MORE LENGTH THAN THE DISCHARGE OFF A PREHEAT COIL IN A 100 PERCENT OUTSIDE AIR HANDLING UNIT.THESE ARE SENSORS FOR STANDARD CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

G. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Provide a minimum of two sensors when coil/duct face area exceeds 149 square feet. Temperature range as required for resolution indicated.

1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3 degrees F accuracy at calibration point.

THESE ARE SENSORS FOR CRITICAL CONTROL AND MONITORING. CONSULT OWNER FOR DIRECTION IN THE APPLICATION OF SENSING ELEMENT TYPES.

H. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Provide a minimum of two sensors when coil/duct face area exceeds 149 square feet. Temperature range as required for resolution indicated.

1. Sensing element shall be platinum RTD, +/- 0.2 degrees C measured at 0 degrees C.

I. Liquid immersion temperature sensor shall include brass thermowell (with thermally-conductive paste), sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15 degrees F.

1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2 degrees C measured at 0 degrees C.
2. All thermowells must be installed in a positive upright position with no downward orientation.

J. Pipe Surface-Mount Temperature Sensor: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally-conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in this Section.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4 degrees F accuracy at calibration point.

K. Outside air sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in this Section.

1. +/- 0.2 degrees C measured at 0 degrees C.

2.08 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy (% RH): +/- 2 percent between 20-90% RH at 77 degrees F, including hysteresis, linearity, and repeatability.
3. Sensor Operating Range: As required by application.
4. Long Term Stability: Less than 1 percent drift per year.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.

2.09 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. Liquid, Steam and Gas:

1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc linear output, adjustable span and zero, stainless steel wetted parts.
2. Ambient Limits: –40 to 175 degrees F (-40 to 121 degrees C), 0 to 100% RH.
3. Process Limits: –40 to 400 degrees F (-40 to 205 degrees C).
4. Accuracy: Less than 0.1 percent.
5. Output Damping: Time constant user selectable from 0 to 36 seconds.
6. Vibration Effect: Less than +/- 0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
7. Electrical Enclosure: NEMA 4, 4X, 7, 9.
8. Approvals: FM, CSA.
9. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa.

B. General Purpose Low Pressure Air: Generally for each measurement of duct pressure, filter differential pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell-type transmitter.

2. Output: Two wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 1 percent.
4. Minimum Range: 0.1 inches w.c.
5. Maximum Range: 10 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Units shall be Setra, Modus T30, Veris PX Series, or Dwyer Series 616.
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A- 301 and connecting tubing.
9. Magnehelic Gauges: Provide Dwyer Series 200 Magnehelic Differential Pressure Gauge (or equal) for each DP transmitter. Provide gauge, mounting bracket, ¼ inch aluminum tubing, static pressure tips, and molded plastic vent valves for each gauge connection. Select range for specified recommended filter loading pressure drop to be 75 percent full- scale. For other DP transmitters select range for specified set point to be between 25 percent and 75 percent full-scale.

C. General Purpose Low Pressure/Low Differential Air: Generally, for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered, two-wire differential capacitance cell type transmitter.
2. Output: Two-wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 1 percent.
4. Minimum Repeatability: +/- 0.25 percent of reading.
5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Vicon critical room control (CRC), Setra, Modus T30.
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A- 301 and connecting tubing.
9. Range: Select for specified set point to be between 25 percent and 75 percent full-scale.

D. VAV Velocity Pressure: Generally for use in variable volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell type transmitter.
2. Output: Two-wire, 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 0.25 percent.
4. Minimum Range: 0 inches w.c.
5. Maximum Range: 1 inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: As included by box manufacturer or Dwyer (third party)
8. Range: Select for minimum range that will accept the maximum velocity pressure expected.
9. Magnehelic Gauges: Provide Dwyer Series 200 Magnehelic Differential Pressure Gauge (or equal) for each DP transmitter. Provide gauge, mounting bracket, ¼ inch

aluminum tubing, static pressure tips, and molded plastic vent valves for each gauge connection. Select range for specified set point to be between 25 percent and 75 percent full-scale.

2.10 AIRFLOW MEASURING STATIONS (AFMS)

E. Fan Inlet Probe: Shall consist of vortex shedding multi-sensor probes which are installed in the inlet of the fan. Individual sensors on the probe provide direct proportional and linear signals to airflow velocity.

1. Sensor Accuracy: +/- 2.0 percent.
2. Interchangeability: +/- 0.5 percent.
3. Velocity Range: 750 to 9000 fpm.
4. Electronics Accuracy: +/- 0.05 percent.
5. Temperature Limits: -20 degrees F to 140 degrees F.
6. Enclosure for Electronics: NEMA 1.
7. Material: Aluminum.
8. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.
9. Acceptable Manufacturers: Ebtron or equal approved by Owner.

F. Thermal Airflow Station: Airflow station shall consist of one or more sensor probes mounted in a casing, and a remotely mounted microprocessor-based transmitter.

1. Performance:

a. Capable of independently processing up to 16 independently wired sensor assemblies.
b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.
d. Listed and labeled according to UL 873, "Temperature-Indicating and Regulating Equipment."
e. Components shall be interconnected by exposed UL listed plenum-rated cable or non-listed cable placed in conduit.
f. Each flow station shall be factory calibrated to standards that are traceable to NIST.
g. Airflow Accuracy: Within 2 percent of reading over the entire operating airflow range. This includes transmitter and sensor.
h. Temperature Accuracy: Within 0.2 degree F over entire operating range of minus 20 to plus 140 degree F.
i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 degree F.
j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 degree F.
k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.
l. Instrument shall compensate for changes in air temperature and density

throughout calibrated velocity range for seasonal extremes.

m. Pressure Drop: 0.05-inch wg at 2000 fpm across a 24-by-24-inch area.

2. Sensor Assemblies:

a. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 304 stainless steel.
b. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.

3. Transmitter:

a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.

4. Acceptable Manufacturers: Ebtron or Air Monitor

G. Air Flow Traverse Probes:

1. Furnish where indicated on the Drawings, vortex shedding multi-sensor insertion type, air flow traverse probes. The probes, and placement of the probes, shall provide measurement accuracy within +/- 2 percent of actual velocity. Probes shall be of cylindrical cross Section.
2. Probes shall be provided with integral mounting plate, 1/4 compression fitting connections, end mounting rod and be suitable to operate in ambient conditions of 200 degrees F. The probe assemblies shall not have a pressure drop greater than 10 percent of the velocity pressure at the maximum design flow. The probes shall not amplify sound levels in the duct.

a. Sensor Accuracy: +/- 2.0 percent.
b. Interchangeability: +/- 0.5 percent.
c. Velocity Range: 400 to 7000 fpm.
d. Electronics Accuracy: +/- 0.05 percent.
e. Temperature Limits: -20 degrees F to 200 degrees F.
f. Enclosure for Electronics: NEMA 1.
g. Humidity Limits: 0 to 100% RH (non-condensing).
h. Material: 304 stainless steel.
i. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.
j. The following schedule is the minimum probe quantities across either the width or height of the duct sections where the probes are being inserted:

Insertion Side (inches)	Quantity
6-11	1
12-30	2
31-48	3

48-60	4
61-84	6
85-120	6

k. Manufacturer: Tek-Air Model VT5000 or equal approved by Owner.

2.11 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve manifold bypass kit for protection of DP sensors where the pressure on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, calibration taps, and a bypass valve contained in a NEMA 1 enclosure.

2.12 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service Auto Reset - Air: Diaphragm with adjustable set point and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal approved by Owner.

B. General Service Manual Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Manual reset shall be readily accessible in reach of personnel installed at height not to exceed 5 feet above finished floor. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal approved by Owner. The High Static Pressure Safety Switch shall alarm to the Building Management System upon activation.

C. General Service - Water: Diaphragm with adjustable set point, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range and 0 degrees F to 160 degrees F operating temperature range.

2.13 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable set point and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150 percent of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, and Honeywell

Pneumatics are only allowed in retrofit applications where the existing BMS is pneumatic and full replacement of the BMS is not warranted by the scope of the project. Coordinate with UH project manager before using pneumatics.

2.14 TRANSDUCERS

A. Consult Owner for direction in the application of Transducers.

B. PNEUMATICS ALLOWED IN RETROFIT APPLICATIONS ONLY

2.15 CURRENT SWITCHES (CS)

A. Clamp-On Design Current Operated Switch (for Constant Speed Motor Status Indication):

1. Range: 2.5 to 135 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 1.0A @ 30VAC/DC.
4. Lower Frequency Limit: 6 Hz.
5. Trip Indication: LED.
6. Approvals: UL, CSA.
7. Max. Cable Size: 350 MCM.
8. Acceptable Manufacturer: Veris Industries H-908.

B. Clamp-on Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A).
1. Acceptable Manufacturers: Veris Industries H938 or RE Technologies RCS 1150.
2. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication:

1. Range: 3.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 0.1A @ 30VAC/DC.
4. Frequency Range: 35 to 75 Hz.
5. Trip Indication: LED.
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM.
8. Acceptable Manufacturer: Veris Industries H-904.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A).

1. Acceptable manufacturer: Veris Industries H934.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.16 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing):

1. Range: 1-10 amps minimum, 20-200 amps maximum.
2. Trip Point: Adjustable.
3. Output: 0-5 VDC.
4. Accuracy: +/- 0.2 percent from 20 to 100 Hz.
5. Acceptable Manufacturer: KELE SA100.

2.17 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. Pressure Sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph.
1. Acceptable Manufacturer: Dwyer A-306.

B. Low Air Pressure Surge Dampener: 30-second time constant.

1. Acceptable Manufacturer: Modus SD030.

2.18 CONTINUOUS LEVEL TRANSMITTERS

A. Capacitance Type:

1. General: Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. Output: 4-20 mA.
3. Probe: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. Electrical Enclosure: NEMA 4 or 7.
5. Approvals: UL or CSA.
6. Accuracy: +/- 1 percent of calibrated span.
7. Process Connection: MPT or ANSI Flange as required.
8. Acceptable Manufacturers: Drexelbrook, Endress & Hauser.

B. Hydrostatic Pressure:

1. General: Two wire smart d/p cell type transmitter.
2. Output: 4-20 mA or 1 to 5 volt user selectable linear or square root output.

3. Range: Adjustable span and zero.
4. Probe: Stainless steel wetted parts.
5. Environmental Limits: –40 to 250 degrees F (-40 to 121 degrees C), 0 to 100% RH.
6. Accuracy: Less than 0.1 percent of span.
7. Output Damping: Time constant user selectable from 0 to 36 seconds.
8. Vibration Effect: Less than +/- 0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7 or 9.
10. Approvals: FM, CSA.
11. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, and Johnson-Yokagawa.

ENGINEER MUST CLEARLY INDICATE WHICH FLOW METERS ARE ACCEPTABLE FOR VARIOUS DUTIES. EDIT TO SUIT THE PROJECT.

Ultrasonic flow meter for water service not currently in use. Consult with UH project manager before using on a project.

2.19 ULTRASONIC FLOW METER FOR WATER SERVICE:

A. General: Single-channel non-wetted ultrasonic meter to measure volumetric fluid using transit- time flow measurement.

B. Measurement: Single channel (Two Channel) measurement.

C. Enclosure: Epoxy-coated aluminum NEMA 4X, IP66 weatherproof.

D. Accuracy: +/- 2 percent of velocity reading at 1 to 40 feet per second.

E. Rangeability: 400 to 1.

F. Repeatability: +/- 0.2 to 0.5 percent at full scale.

G. Input Power: 120 VAC or 24VDC.

H. Operating Temperature: 14 degrees F to 140 degrees F.

I. Control Panel: Stainless Steel case. Digital display: 2-line x 16-character LCD display, LED backlight, configurable to display up to 4 measurement parameters in sequence.

J. Keypad: 6-button internal keypad.

K. Output: Single Channel – one 4-20 mA (Two Channel – two 4-20 mA).

L. Output Units: Velocity in feet per second or meters per second.

M. Volumetric Flow: Cubic feet (ft3), cubic meters (m3), gallons (gal), and liters (L).

N. Totalizer (forward and reverse): Cubic feet (ft3), cubic meters (m3), gallons (gal), and liters (L).

O. Transducer Temperature Range: –40 degrees F to 140 degrees F.

P. Provide all slide track brackets, stainless steel chain or strap, for a complete installation. Provide connecter cables and connectors as required for a complete system.

Q. BACnet compatible.

R. Acceptable Manufacturer: EMCO.

2.20 ULTRASONIC FLOW METER FOR STEAM SERVICE:

A. General: Single-channel ultrasonic meter to measure the mass flow rate of saturated or superheated steam and the volumetric flow of wet steam.

B. Measurement: Single Channel measurement.

C. Enclosure: Stainless steel NEMA 7/4X.

D. Accuracy: +/- 1 percent of velocity reading at 3 to 150 feet per second.

E. Rangeability: 1500 to 1.

F. Repeatability: +/- 0.2 to 0.5 percent at 1 to 150 feet per second.

G. Input Power: 120 VAC or 24 VAC/VDC.

H. Operating Temperature: -40 degrees F to 140 degrees F.

I. Display: 2-line x 16-character LCD display, LED backlight, configurable to display up to 4 measurement parameters in sequence.

J. Output: 4-20 mA.

K. Transducer:

1. Type: T9.
2. Temperature Range: –40 degrees F to 400 degrees F.
3. Pressure Ratings: 0 to 250 psig operating pressure, 750 psig test pressure
4. Material: Titanium.
5. Connection: Threaded or flanged connection.

L. BACnet compatible.

M. Acceptable Manufacturer: EMCO Steam Flow Transmitter.

2.21 INSERTION TYPE TURBINE METER FOR WATER SERVICE:

A. General Requirements:

1. Dual Turbine Flow Meter with non-magnetic impedance sensing method, low-mass non-metallic turbines with sapphire jewel bearings and tungsten carbide shafts.
2. Turbine Insertion Flow Meter shall have maximum operating pressure of 400 psi and maximum operating temperature of 200 degrees F continuous (220 degrees F peak).
3. All wetted metal parts shall be constructed of 316 stainless steel. Flow meter shall meet or exceed all of the accuracy, head loss, flow limits, pressure and material requirements of the AWWA standard C704-70 for the respective pipe or tube size.
4. Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1 percent of span, voltage output of 0-10 V, and current output of 4-20 mA.

B. Installation: Install in water systems with a minimum of 10 pipe diameters unobstructed flow upstream of water meter and a minimum of 5 pipe diameters unobstructed flow downstream of water.

C. BACnet compatible.

D. Acceptable Manufacturers: Onicon Corp. F-1200, Badger and Hersey.

2.22 VORTEX SHEDDING FLOW METER FOR LIQUID, STEAM AND GAS SERVICE:

A. General Requirements:

1. Steam meter shall operate as a loop powered device, with a 4 - 20 mA output signal for flow rate and a scalable pulse output. Provide built-in display for flow rate and total data, instantaneous temperature, operating status and diagnostic data

B. BACnet compatible.

C. Acceptable Manufacturers: Onicon Corp. F-2500, Foxboro 83 series, Johnson-Yokagawa, and Rosemount.

2.23 MAGNETIC FLOW METER FOR WATER SERVICE:

A. General Requirements:

1. Sensor shall be a magnetic flow meter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe.
2. The flow meter shall consist of two (2) elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
3. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).

    a. Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube.

b. Output: 4-20 mA.
c. Flow Tube: Stainless steel.
d. Electrical Enclosure: NEMA 4, 7.
e. Approvals: UL or CSA.
f. Stability: 0.1 percent of rate over six (6) months.
g. Process Connection: Carbon steel, ANSI 150 LB, size as required.

B. Meter Accuracy:

1. Under the reference conditions of a 68 degrees F media temperature, a 68 degrees F ambient temperature, a +/- 1 percent nominal power supply voltage, 10 diameters up stream and 5 down of straight piping and a fully developed flow profile; the meter must meet the following requirements:
2. Plus or minus 0.8 percent of reading accuracy in the flow range of 1.65 - 33 feet per second +/- (0.66/Velocity actual feet per second +0.4) percent of reading accuracy in the flow range of 0 - 1.65 feet per second.
3. Meter repeatability shall be +/- 0.1 percent of rate at velocities greater than 1.65 feet per second.

C. Calibration: The sensor must be calibrated on an internationally accredited (i.e. NAMAS) flow rig with accuracy better than 0.1 percent. Calibration shall be traceable to National Institute of Standard and Technology.

D. Construction:

1. The meter piping material shall be AISI 304 stainless steel.
2. The meter flange and enclosure material shall be carbon steel.
3. The external surface of the sensor is to be treated with at least .006 inches (150 µm) of Corrosion resistant two-component paint.
4. The inner meter piping shall be protected with a neoprene liner or similar liner.
5. The electrode material shall be AISI 316 Ti or better.
6. The sensor be ANSI class 150 pounds.

E. Electronics:

1. The sensor shall contain a SENSOR-PROM, storing calibration and factory default settings, i.e. the identification of the sensor and size.
2. An ISO 9001 approved company shall manufacture the sensor and electronics.
3. As standard, the electronics must be installable directly on the sensor or installable (remote) up to 1500 feet from the sensor as a maximum.
4. With local electronics installation, the electronics shall be able to withstand three (3) feet water submersion for up to 30 minutes.
5. The electronics shall be compatible with the following power specifications:

a. 15/230 Vac +10 percent to 15 percent 50-60 Hz.
b. The power consumption must be 10 Watts or less independent of meter size.

6. The meter electronics shall be able to produce simultaneous scalable current and frequency/pulse output. The frequency output shall be linearly proportional to flow rate and scalable from 0-10 kHz. The pulse output shall be scalable from 50 to 5000 milliseconds duration, suitable for an electromechanical totalizer in engineering units.
7. The electronics must have an internal totalizer for summation of flow.
8. The output of the electronics must be individually, galvanically isolated with an isolation voltage of more than 500 V.

F. Output:

1. The current signal must be either 0-20 mA or 4-20 mA proportional to the flow velocity.
2. The output current signal must accommodate 20 percent over range without loss in linearity.
3. The electronics shall have an alphanumeric LCD display showing actual flow and totalized flow in engineering units.
4. The display and keyboard must be rotatable so that the display can be viewed regardless of sensor orientation.

G. Error Detection:

1. The electronics must be able to detect the flowing error conditions:

    a. Signal connection between electronics and sensor interrupted.
    b. Loss of current to the coil circuit.
    c. Load on the current output.
    d. Defective electronics.
    e. Defective sensor.
    f. Empty pipe.

2. The electronics must have an Error Log where all error conditions occurring within a period of 180 days are stored.

H. Electronic Replacement Programming:

1. The electronics must be immediately replaceable without the need of cable disconnection or renewed configuration programming.
2. When the supply voltage is applied, the electronics must self-configure and display flow without keyboard contact (no programming required).
3. The electronics must be provided with an automatic zero flow setting.
4. The electronics shall be programmable with respect to:

    a. User display options and menu
    b. Setting data
    c. Configuration of outputs
    d. Zero ‘cut-off’ from 0 percent to 9.9 percent of maximum flow.

5. For ease of programming, the electronics shall be programmable away from the meter using the meter Sensor-Prom and a 9 V battery.
6. The electronics shall be suitable for operation in an ambient temperature range of -4 degrees F to 120 degrees F.

I. BACnet compatible.

J. Acceptable Manufacturers:

1. Engineering Measurements Co. (EMCO MAG 3100 with a model MAG 2500 electronic transmitter and display).
2. Rosemount.
3. Toshiba.
4. Hersey Measurement.
5. Yokogawa Industrial Automation.
6. Endress & Hauser.

2.24 VENTURI FLOW METER FOR WATER SERVICE

A. Flow Sensing Element: Differential-pressure Venturi-type designed for installation in piping.

B. Construction: Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2 inches and smaller and flanged or welded for larger than 2 inches.

C. Differential transmitter shall be dual range industrial grade as specified above.

D. Connect differential pressure to Venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.

E. Apply Venturi-type flow meters where minimum flow range is no less than 40 percent of maximum flow.

2.25 CO2 SENSORS/TRANSMITTERS (CO2)

A. General: CO2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual- wavelength sensor.

B. Accuracy: +/- 36ppm at 800 ppm and 68 degrees F.

C. Stability: 5 percent over 5 years.

D. Output: 4-20 mA, 0-10 Vdc or relay.

E. Mounting: Duct or Wall as indicated.

F. Acceptable Manufacturer: Vaisala, Inc. GMD20 (duct) or GMW20 (wall).

2.26 MISCELLANEOUS ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D or Allen Bradley.

B. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2- way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. Coil Enclosure: Indoors shall be NEMA 1, Outdoors shall be NEMA 3, 4, 7, 9.
2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 degrees F (66 degrees C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
3. Acceptable Manufacturers: EP valves as manufactured by ASCO or Parker.
4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. Low Temperature Detector ('Freezestat') (FZ): Low temperature detector shall consist of a 'cold spot' element that responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8 inches x 20 feet (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPDT (4 wire, 2 circuit) with manual reset. Manual reset shall be readily accessible in reach of personnel installed at height not to exceed 5 feet above finished floor. Temperature range 15 to 55 degrees F (-9.4 to 12.8 degrees C), factory set at 38 degrees F. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each five square feet of cooling coil/duct face area. The Low Temperature Detector shall alarm to the Building Management System upon activation.

D. High Temperature Detectors ('Firestat') (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215 degrees F (-4 to 102 degrees C).

E. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150 degrees F (10 to 65 degrees C), and a minimum 10 degrees F fixed set point differential.

F. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed contacts, operating temperature range of 50 to 90 degrees F (10 to 32 degrees C), switch rating of 24 Vac (30 Vac maximum), and both manual and automatic fan operation in both the heat and cool modes.

G. Control Relays: All control relays shall be UL listed, with contacts rated for the application,

and mounted in minimum NEMA 1 enclosure for indoor locations, NEMA 4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

    a. AC coil pull-in voltage range of +10 percent, -15 percent or nominal voltage.
    b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
    c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
    d. Pilot light indication of power-to-coil. Pilot light shall be visible from a standing position of 5 feet AFF
    e. Coil rated for 50 and 60 Hz service.
    f. Relays shall be labeled to identify the function or purpose per 26 05 53 Identification for Electrical Systems. Coordinate with owner for approved verbiage of labels.
    g. Acceptable Manufacturers: Relays shall be Functional Devices (RIB), Potter Brumfield, Model KRPA or equal approved by Owner.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 horsepower, and 1/3 horsepower, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC or approved equal.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
4. All safety circuits shall be installed to operate individual interposing relays located in the associated equipment control panel. Each safety device (i.e. Freezestat, DP safety, smoke detector, firestat, etc.) wiring circuit shall be installed with individual homeruns back to the associated control panel. See control drawings for details.

H. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA 1 enclosure.
    1. Acceptable Manufacturers: Square 'D', Cutler-Hammer or Westinghouse.

I. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be UL and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 air vented enclosure. Multiple transformers in a single enclosure shall have fan aided ventilation whenever ambient temperature exceeds 140 Deg F.

    1. Transformers shall be manufactured by Westinghouse, Square ‘D’, or Jefferson.

J. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a NEMA 1

enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
2. TDRs shall be UL and CSA listed, Crouzet type.

K. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley or equal approved by Owner.

L. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley or equal approved by Owner.

M. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory or equal approved by Owner.

N. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley or equal approved by Owner.

ENGINEER MUST CLEARLY INDICATE WHICH REFRIGERANT MONITORS ARE ACCEPTABLE FOR THE APPLICATION. ONLY SPECIFY THE REFRIGERANT MONITOR IN THIS SECTION IF NOT PROVIDED BY THE CHILLER MANUFACTURER IN THE CHILLER SPECIFICATION. EDIT TO SUIT THE PROJECT.

2.27 REFRIGERANT MONITOR

A. General: Contractor shall provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect [**R134a**][**R123**][**R410a**][**R514a**][**Insert other refrigerant type here**] refrigerants used in chiller equipment installed under Division 23. The alarm system shall comply with the latest edition of ANSI/ASHRAE 15 and local code requirements.

B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through 100 PPM. Readings above 100 PPM must be accurate to within +/- 5 percent of reading. Accuracy shall be maintained within ambient environmental ranges of 0 degrees C through 50 degrees C, (32 degrees F through 122 degrees F) and 5 percent through 90 percent relative humidity, non- condensing.

C. The refrigerant monitor shall automatically and continuously monitor the areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufacturer's instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacturer. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.

D. The analyzer will be based on infrared detection technology and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.

E. The monitor shall be equipped with four (4) outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a liner scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.

F. The monitor shall have a NEMA 4 enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.

G. The following alarm modes will be provided by the refrigerant monitor:

1. Alarm Level One: Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adjustable) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BMS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.
2. Alarm Level Two: This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25 percent below the maximum calculated refrigerant level specified in the latest editions of ANSI/ASHRAE 15 and ASHRAE 34. This alarm will be displayed on the monitor interface and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will

also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BMS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

3. Alarm Level Three: This alarm shall be set at the maximum calculated refrigerant level specified in the latest editions of ANSI/ASHRAE 15 and ASHRAE 34whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event and will de-energize the energy source for any hot surface (850 degrees F or 454 degrees C) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BMS through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

H. All alarm conditions shall be reported to the BMS system as follows:

1. Alarm Level One: The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BMS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.
2. Alarm Level Two: The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BMS system indicating a high level alarm on the BMS operator terminal(s). This BMS alarm shall state that high levels of refrigerant have been detected in the designated area.
3. Fault Alarm: Reports a high level alarm to the BMS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.

2.28 NAMEPLATES

A. Provide engraved phenolic nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 inch thick, black, with white center core, and shall be minimum 1 inch x 3 inch, with minimum ¼ inch high block lettering. Nameplates for devices smaller than 1 inch x 3 inch shall be attached to adjacent surface. Each nameplate shall identify the function for each device.

2.29 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete

test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5 percent accurate, test equipment shall be +/- 0.25 percent accurate over same range).

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of the latest edition of the National Electrical Code and all local codes.

D. Main Control Air Piping: All main air piping between the compressors and the control panels shall be copper, run per ASTM B88

E. Branch Control Air Piping: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels; across roofs, in pipe chases, etc. Inaccessible tubing is defined as that tubing run in concrete slabs; furred walls; or ceilings with no access.

1. Provide copper tubing with maximum unsupported length of three (3) feet for accessible tubing run exposed to view. Terminal single-line connections less than 18 inches length may be copper tubing, or polyethylene tubing run. Tubing exposed to ambient conditions must be properly protected from environmental conditions and protected from damage.
2. Provide copper tubing for inaccessible tubing, other than in concrete pour. In a concrete pour polyethylene tubing may be used, install in rigid conduit or vinyl-jacketed polyethylene tubing. Install in galvanized rigid steel conduit at all exterior locations. Install in PVC Schedule 40 conduit if encased in concrete.
3. Polyethylene tubing may be used in control panels provided it is run in a neat and orderly fashion, bundled where applicable, properly supported and installed in a neat and workman like manner. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion.

4. Pressure test control air piping at 30 psi (207 kPa) for 24 hours. Test fails if more than 2 psi loss occurs.
5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

F. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring exposed in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the National Electrical Code and Division 26. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with the latest edition of the National Electrical Code and Division 26.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All WAN and LAN patch cords shall be approved and installed as directed by owner.
5. BMS low voltage wiring/cables: All cables shall have legible printed sleeve identification labels at each device and the panel termination.

    a. Labels shall be high temperature permasleeve (TM) Marker, such as Brady PermaSleeve TM, part number - "BPSPT-187-175-WT" or equal approved by Owner.
    b. Each label shall be identified with the entire BMS point name utilized in the BMS database and the point address.

ENGINEER SHALL CONSULT WITH OWNER PRIOR TO ALLOWING EXPOSED CABLE AND INCLUDING THE APPLICABLE PARAGRAPHS.

6. Terminate all control wiring internal to panels to screw terminal connections or owner approved wire connection equivalent. Wire nuts and/or splices are not allowed in panels. When terminating a wire cable, the cable jacket, cable shielding wire, and cable shielding material shall be finished in a neat consistent workmanlike manner.
7. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a

submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.

8. Communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured.

   a. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

   b. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.

9. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed five (5) foot intervals. Communication wiring may not be bundled with electrical nor with fire alarm wiring. All in-wall communication wiring must be run in a ¾ inch minimum conduit. Wiring passing thru a fire-rated partition must be fire-caulked.

   a. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling, duct, or light fixtures. Wiring run down the wall in conduit shall have one loop of additional slack.

   b. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.

10. Secondary LAN Communication cabling: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26. Wiring/cables shall be provided in a customized color jacketing material. Color coding shall be green or orange. Material and labeling hall be as specified in Section 27 0553 “Identification for Communication Systems”.
11. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

G. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. [Refer to Figure C at end of Section] Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

H. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally, where flow is sufficiently

homogeneous/adequately mixed at sensing location, consult Engineer for requirements.

ENGINEER MUST SPECIFICALLY SHOW LOCATIONS OF ALL FLOW MEASURING STATIONS AND FLOW METERS AND DESIGN THE STRAIGHT LENGTH OF DUCT OF PIPE REQUIRED FOR ACCURATE SENSORS. THIS LENGTH MUST BE SPECIFICALLY SHOWN ON THE DRAWING AND BE ADEQUATE FOR THE INSTALLATION.

I. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

J. Hydronic and Steam Flow Meters: Install with the manufacturer's recommended upstream and downstream unobstructed clearances.

K. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

L. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

M. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

N. Steam Differential Pressure Transmitters: Install per manufacturer's instructions at location as shown on the Drawings,

O. Pipe Surface Mount Temperature Sensors: Install with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.

P. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

Q. Current Switches for Motor Status Monitoring: Adjust so that set point is below minimum operating current and above motor no-load current.

R. Supply Duct Pressure Transmitters:

1. General: Install pressure tips with at least four (4) 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the straightest run in the air system.

S. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

3.03 REFRIGERANT MONITOR INSTALLATION

A. Install in accordance with the manufacturer's instructions. Place sensing tips in locations to maximize effectiveness.

B. Provide hard wire interlocks to the emergency ventilation and shutdown of combustion devices. Visual and audible alarms are required.

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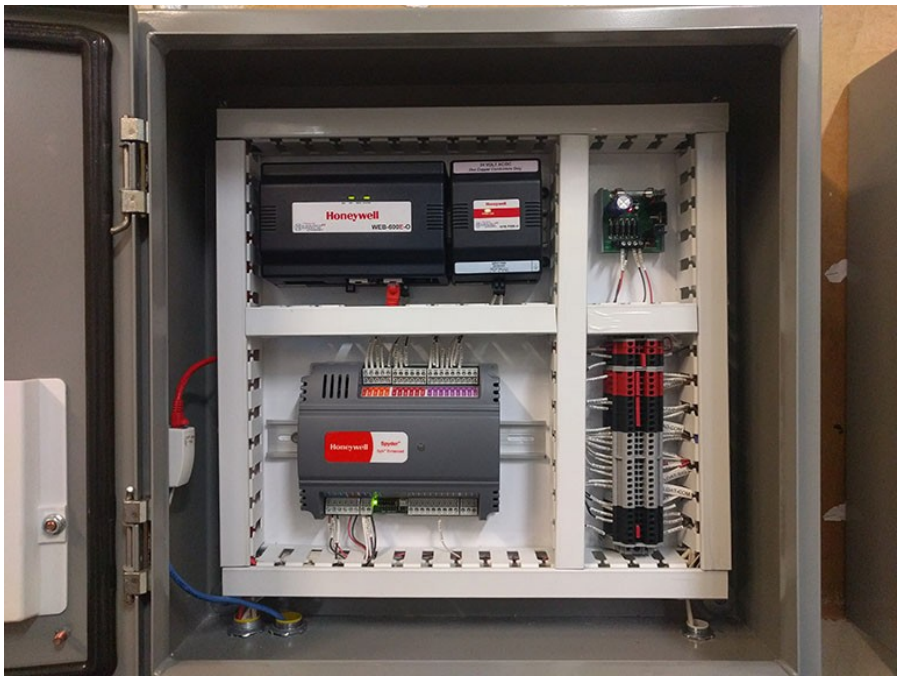
3.04 PANEL INSTALLATION

A. Figures A and B (below) illustrate the required layout of a BMS Panel in new construction.



END OF SECTION 25 1100

FOR CONTROL VALVES, ENGINEER SHALL COMPLETE THE APPLICABLE FOLLOWING FORMS FOR EACH INDIVIDUAL APPLICATION AND/OR VALVE. CONTROL VALVE SIZING AND SELECTION IS THE INITIAL RESPONSIBILITY OF THE ENGINEER AND NOT LEFT TO THE BMS PROVIDER. THE ITEMS NOTED WITH A * AND *,** SHALL BE COMPLETED BY THE ENGINEER TO LIST THE REQUIREMENTS OF THE VALVES FOR CV, CLOSE OFF, TEMPERATURE RATINGS, CAGE MATERIAL, SEAT MATERIAL, TRIM MATERIAL ETC. FOR EACH INDIVIDUAL APPLICATION. THIS SHOULD BE A RESULT OF ANALYZING THE VALVES PERFORMANCE AND APPLICATION ACROSS THE RANGE OF CONTROL. ENGINEER SHALL CONSULT WITH OWNER PRIOR TO SPECIFYING THESE VALVES.

DELETE THE TEXT IN BLUE ABOVE AND THIS SENTENCE WHEN EDITING OF THIS SECTION IS COMPLETED.

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University of Houston									
Steam Control Valve Specification Sheet (Globe Body)									
Project Name		Revisions				SHEET		xx of xx	
		NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION	
		1				15951		*	
		2				CONTRACT		DATE	
		3				X		mm/dd/yy	
		4				PROJECT NUMBER			
		5				XXXX.XX			
		6				BY	CHECKED	APPROVED	
		7				XYZ	XYZ	XYZ	
GENERAL	Tag Number	*							
	Service Description	*							
	P&ID Sheet Number	*							
	Line No. or Vessel No.	*							
	Line Size / Mat'l / Sch.	*							
	Electrical Class / Power Supply	*			*				
PROCESS DATA	Fluid / Fluid State	SATURATED STEAM <125 PSIG			VAPOR				
	Operating Condition	Units	Minimum	Normal	Maximum	Other			
	Flow Rate	LB/HR	*	*	*	*			
	Inlet Pressure	PSIG	*	*	*	*			
	Outlet Pressure	PSIG	*	*	*	*			
	Temperature	DEG F	*	*	*	*			
	Mol. Wt.								
	Sp. Wt / Sp. Grav								
	Viscosity / Sp Heat								

BODY	Style	Size	GLOBE	xx"
	End Connection	Rating	xx" RF FLANGED	ANSI CLASS 150
	Port Size	Travel	*	*
	Valve Cv	Valve C1/Km	*	**
	Body Matl.	Bonnet	ASTM A216 WCB	ASTM A216 WCB
	Characteristic	Trim Number	EQUAL PERCENTAGE	*,**
	Cage Matl.	Retainer Matl.	*	*
	Seat Matl.	Seat Ring Matl.	*,**	*,**
	Plug Matl.	Stem Matl.	*,**	*,**
	Flow Action		DOWN	
	Gaskets		SPIRAL METALLIC	
	Stem Guide		**	
	Packing		GLASS FILLED PTFE**	
	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		PNEUMATIC	
	Size	Bench Set	*	*
	Push-Down To	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	6 PSIG*	30 PSIG*
	Handwheel		NONE*	
POSITIONER	Type		Electronic	
	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	
	Output Signal		*	

OPTIONS	Air Set w/ Gauges	YES*
	Solenoids	*
	Position Switches	*
SELECTION BASED ON	Manufacturer	Fisher, Valtek, Dezurik-Copes, Leslie, Belimo
	Valve Model Number	*
	Actuator Model No.	*
	Positioner Model No.	*
	Filter Regulator	YES
NOTES	**, ** Engineer to consult with and use manufacturer's recommended steam trim for the service, usually a hardened 400 series stainless steel.* ** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*	

University of Houston										
Water Control Valve Specification Sheet (Globe Body)										
Project Name		Revisions					SHEET		xx of xx	
		NO.	BY	DATE	DESCRIPTION		SPEC. NO.		REVISION	
		1					15951		*	
		2					CONTRACT		DATE	
		3					X		mm/dd/yy	
		4					PROJECT NUMBER			
		5					XXXX.XX			
		6					BY	CHECKED	APPROVED	
		7					XYZ	XYZ	XYZ	
GENERAL	Tag Number		*							
	Service Description		*							
	P&ID Sheet Number		*							
	Line No. or Vessel No.		*							
	Line Size / Mat'l / Sch.		*							
	Electrical Class	Power Supply	*			*				
PROCESS DATA	Fluid	Fluid State	WATER			LIQUID				
	Operating Condition		Units	Minimum	Normal	Maximum	Other			
	Flow Rate		GPM	*	*	*	*			
	Inlet Pressure		PSIG	*	*	*	*			
	Outlet Pressure		PSIG	*	*	*	*			
	Temperature		DEG F	*	*	*	*			
	Level		FEET	*	*	*	*			
	Mol. Wt.									
	Sp. Wt	Sp. Grav								
	Viscosity	Sp Heat								

BODY	Style	Size	GLOBE	xx"
	End Connection	Rating	xx" RF FLANGED	ANSI CLASS 150
	Port Size	Travel	*	*
	Valve Cv	Valve C1/Km	*	**
	Body Matl.	Bonnet	ASTM A216 WCC	ASTM A216 WCC
	Characteristic	Trim Number	EQUAL PERCENTAGE	**
	Cage Matl.	Retainer Matl.	*	*
	Seat Matl.	Seat Ring Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Plug Matl.	Stem Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Flow Action		DOWN	
	Gaskets		PTFE	
	Stem Guide		**	
	Packing		PTFE	
	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		PNEUMATIC	
	Size	Bench Set	*	*
	Push-Down To	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	6 PSIG*	30 PSIG*
	Handwheel		NONE*	
POSITIONER	Type		Electronic	
	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	
	Output Signal		*	
OPTIONS	Air Set w/ Gauges		YES*	
	Solenoids		*	
	Position Switches		*	

SELECTION BASED ON	Manufacturer	Fisher, Valtek, Dezurik-Copes, Leslie, Belimo
	Valve Model Number	*
	Actuator Model No.	*
	Positioner Model No.	*
	Filter Regulator	YES
NOTES	** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*	

University of Houston									
Water Control Valve Specification Sheet (Globe Body)									
Project Name			Revisions				SHEET		xx of xx
			NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION
			1				15951		*
			2				CONTRACT		DATE
			3				X		mm/dd/yy
			4				PROJECT NUMBER		
			5				XXXX.XX		
			6				BY	CHECKED	APPROVED
			7				XYZ	XYZ	XYZ
GENERAL	Tag Number		*						
	Service Description		*						
	P&ID Sheet Number		*						
	Line No. or Vessel No.		*						
	Line Size / Mat'l / Sch.		*						
	Electrical Class	Power Supply	*			*			
PROCESS DATA	Fluid	Fluid State	WATER			LIQUID			
	Operating Condition		Units	Minimum	Normal	Maximum	Other		
	Flow Rate		GPM	*	*	*	*		
	Inlet Pressure		PSIG	*	*	*	*		
	Outlet Pressure		PSIG	*	*	*	*		
	Temperature		DEG F	*	*	*	*		
	Level		FEET	*	*	*	*		
	Mol. Wt.								
	Sp. Wt	Sp. Grav							
	Viscosity	Sp Heat							

BODY.	Style	Size	GLOBE	xx"
	End Connection	Rating	xx" RF FLANGED	ANSI CLASS 150
	Port Size	Travel	*	*
	Valve Cv	Valve C1/Km	*	**
	Body Matl.	Bonnet	ASTM A216 WCC	ASTM A216 WCC
	Characteristic	Trim Number	EQUAL PERCENTAGE	**
	Cage Matl.	Retainer Matl.	*	*
	Seat Matl.	Seat Ring Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Plug Matl.	Stem Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Flow Action		DOWN	
	Gaskets		PTFE	
	Stem Guide		**	
	Packing		PTFE	
	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		PNEUMATIC	
	Size	Bench Set	*	*
	Push-Down To	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	6 PSIG*	30 PSIG*
	Handwheel		NONE*	
POSITIONER	Type		Electronic	
	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	
	Output Signal		*	
OPTIONS	Air Set w/ Gauges		YES*	
	Solenoids		*	
	Position Switches		*	

SELECTION BASED ON	Manufacturer	Fisher, Valtek, Dezurik-Copes, Leslie, Belimo
	Valve Model Number	*
	Actuator Model No.	*
	Positioner Model No.	*
	Filter Regulator	YES
NOTES	** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*	

University of Houston										
Water Control Valve Specification Sheet (Pressure Independent, ½"-2")										
Project Name			Revisions				SHEET		xx of xx	
			NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION	
			1				15951		*	
			2				CONTRACT		DATE	
			3				X		mm/dd/yy	
			4				PROJECT NUMBER			
			5				XXXX.XX			
			6				BY	CHECKED	APPROVED	
			7				XYZ	XYZ	XYZ	
GENERAL	Tag Number		*							
	Service Description		*							
	P&ID Sheet Number		*							
	Line No. or Vessel No.		*							
	Line Size / Mat'l / Sch.		*							
	Electrical Class	Power Supply	*			*				
PROCESS DATA	Fluid	Fluid State	WATER			LIQUID				
	Operating Condition		Units	Minimum	Normal	Maximum	Other			
	Flow Rate		GPM	*	*	*	*			
	Inlet Pressure		PSIG	*	*	*	*			
	Outlet Pressure		PSIG	*	*	*	*			
	Temperature		DEG F	*	*	*	*			
	Level		FEET	*	*	*	*			
	Mol. Wt.									
	Sp. Wt	Sp. Grav								
	Viscosity	Sp Heat								
BODY.	Style	Size	Pressure Independent				xx"			
	End Connection	Rating	xx" Female NPT				400 PSI			
	Body Matl.	Characteristic.	Forged Brass, Nickel Plated				Equal Percentage			
	Char. Disc ½" & ¾"	Char. Disc 1"-2"	Brass				TEFZEL®			

	Diaphragm ½" & ¾"	Diaphragm 1"-2"	Silicone and Nomex	Polyester Reinforced Silicone
	Seat Matl.	Seat Ring Matl.	Fiberglass reinforced Teflon® PTFE	Viton®
	Ball Matl.	Stem Matl.	Chrome Plated Brass	Chrome Plated Brass
	Valve Action		Rotary	
	Regulator Components		Stainless Steel, Brass, Delrin 500AF	
	Spring		Stainless Steel	
	Packing		2 EPDM O-Rings	
	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		Electronic	
	Size	Bench Set	*	*
	Normal Position	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	2 VDC	10 VDC
	Manual Overide		*	
OPTIONS	Feedback		YES*	
	Position Switches		*	
	Service Tool/Software		YES*	
SELECTION BASED ON	Manufacturer		Fisher, Valtek, Dezurik-Copes, Leslie, Belimo	
	Valve Model Number		*	
	Actuator Model No.		*	
NOTES	** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*			

University of Houston										
Water Control Valve Specification Sheet (Pressure Independent, 2½"-6")										
Project Name		Revisions				SHEET		xx of xx		
		NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION		
		1				15951		*		
		2				CONTRACT		DATE		
		3				X		mm/dd/yy		
		4				PROJECT NUMBER				
		5				XXXX.XX				
		6				BY	CHECKED	APPROVED		
		7				XYZ	XYZ	XYZ		
GENERAL	Tag Number	*								
	Service Description	*								
	P&ID Sheet Number	*								
	Line No. or Vessel No.	*								
	Line Size / Mat'l / Sch.	*								
	Electrical Class / Power Supply	*			*					
PROCESS DATA	Fluid / Fluid State	WATER			LIQUID					
	Operating Condition	Units	Minimum	Normal	Maximum	Other				
	Flow Rate	GPM	*	*	*	*				
	Inlet Pressure	PSIG	*	*	*	*				
	Outlet Pressure	PSIG	*	*	*	*				
	Temperature	DEG F	*	*	*	*				
	Level	FEET	*	*	*	*				
	Mol. Wt.									
	Sp. Wt / Sp. Grav									

	Viscosity	Sp Heat			
BODY.	Style	Size	Pressure Independent		xx"
	End Connection	Rating	xx" ANSI 125 Flange		ANSI 125, Standard Class B
	Body Matl.	Characteristic.	Cast Iron-GG25 and Ductile Iron-GGG50		Equal Percentage
	Char. Disc 2”-3”	Char. Disc 4”-6”	Stainless Steel		Stainless Steel
	Seat Matl.	Seat Ring Matl.	PTFE		PTFE
	Ball Matl.	Stem Matl.	Stainless Steel		Stainless Steel
	Valve Action		Rotary		
	Packing		2 EPDM O-Rings		
	Required Seat Tightness		ANSI CLASS IV		
	Max. Allowable Sound Level (dBA)		<75 dBA		
ACTUATOR	Type		Electronic		
	Size	Bench Set	*		*
	Normal Position	Fail Position	CLOSE*		CLOSE*
	Flow Sensor Type		Magnetic		
	Manual Overide		*		
OPTIONS	Feedback		YES*		
	Position Switches		*		
	Service Tool/Software		YES*		
SELECTION BASED ON	Manufacturer		Fisher, Valtek, Dezurik-Copes, Leslie, Belimo		
	Valve Model Number		*		
	Actuator Model No.		*		
NOTES	** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*				