

SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air supply system.
- B. Thermostats.
- C. Humidistats.
- D. Control valves.
- E. Automatic dampers.
- F. Damper operators.
- G. Miscellaneous accessories.

1.02 RELATED REQUIREMENTS

- A. Section 22 0519 - Meters and Gages for Plumbing Piping: Thermometer sockets, gage taps.
- B. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 23 0519 - Meters and Gages for HVAC Piping: Thermometer sockets, gage taps.
- D. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- E. Section 23 0923 - Direct-Digital Control System for HVAC.
- F. Section 23 0993 - Sequence of Operations for HVAC Controls.
- G. Section 23 2113 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gauge taps.
- H. Section 23 2114 - Hydronic Specialties.
- I. Section 23 2213 - Steam and Condensate Heating Piping: Installation of control valves, flow switches, temperature sensor sockets, gauge taps.
- J. Section 23 3300 - Air Duct Accessories: Installation of automatic dampers.
- K. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.
- L. Section 26 2726 - Wiring Devices: Elevation of exposed components.

1.03 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.
- B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- D. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- E. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- F. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- G. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems; 2000 (Reapproved 2011).
- H. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics; 2015.
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- K. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Design Data: Provide design data for sizing and selection of compressor.
- E. Manufacturer's Instructions: Provide for all manufactured components.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- H. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at Michigan.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience approved by manufacturer.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.03 CONTROL VALVES

- A. Globe Pattern:
 - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 - 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel.

- c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
- 4. Steam Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel. Pressure drop across any steam valve at maximum flow shall be as shown on the Drawings.
 - c. Size for 10 psig inlet pressure and 5 psig pressure drop.
 - d. Valves shall have modified linear characteristics.
- B. Butterfly Pattern:
 - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
 - 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.
- C. Electronic Operators:
 - 1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 2. Select operator for full shut off at maximum pump differential pressure.
- D. Radiation Valves:
 - 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
 - 2. Rate for service pressure of 125 psig at 250 degrees F.
 - 3. Size for 3 psig maximum pressure drop at design flow rate.
 - 4. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
 - 5. Operators (2 Position): Synchronous motor with enclosed gear train, dual return springs, valve position indicator; 24 v DC, 0.4 amp. Valves shall spring return to normal position for temperature protection.
 - 6. Operators (Modulating): Self contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

2.04 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric inflatable mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Oil impregnated sintered bronze.
- G. Linkage Bearings: Oil impregnated sintered bronze.
- H. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.
- I. Maximum Pressure Differential: 6 inches wg.
- J. Temperature Limits: -40 to 200 degrees F.

2.05 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 2. Provide one operator for maximum 36 sq ft damper section.
- B. Electric Operators:
1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.
- C. Inlet Vane Operators:
1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

2.06 HUMIDISTATS

- A. Room Humidistats:
1. Wall mounted, proportioning type.
 2. Throttling range: Adjustable 2 percent relative humidity.
 3. Operating range: 30 to 80 percent.
 4. Maximum temperature: 110 degrees F.
 5. Cover: Set point indication.

2.07 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
1. Manufacturers:
 - a. Trane USA _____ . www.trane.com
 2. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 3. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 4. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 5. Temperature sensing device must be compatible with project DDC controllers.
 6. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 - 20 mA.
 - c. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - 3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
 - d. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - e. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - f. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for surface.
 - 2) Provide a four button keypad with the following capabilities:

- (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint.
 - (c) Manual occupancy override and indication of occupancy status.
 - (d) Controller mode status.
- B. Humidity Sensors:
1. Manufacturers:
 - a. Trane USA_____. www.trane.com
 2. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
 - a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
 - b. Output Voltage type: 3-wire observed polarity.
 - c. Humidity:
 - 1) HS Element: Digitally profiled thin-film capacitive.
 - 2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.
 - (a) Plus/minus 1 percent at 20-40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
 - 3) Scaling: 0-100 percent RH.
 - d. Temperature Effect:
 - 1) Duct Mounted: Plus/minus 0.18 percent per degree F.
 - 2) Outdoor Mounted: 4-20mA version: $(0.0013 \times \%RH \times (T_{\text{degreeC}} - 25))$.
 - e. Hysteresis: 1.5 percent typical.
 - f. Linearity: Included in accuracy specification.
 - g. Reset Rate: 24 hours.
 - h. Stability: Plus/minus 1 percent @ 68 degrees F (20 degrees C) annually, for two years.
 3. Wall Mounted Sensor: Voltage type encased in a plastic housing.
 - a. Input Power, Voltage Type: Class 2; 12-24 VDC/24 VAC.
 - b. Output Voltage type: 0-10 V.
 - c. Humidity:
 - 1) HS Element: Digitally profiled thin-film capacitive.
 - 2) Accuracy 2 percent at 10 to 80 percent relative humidity at 77 degrees F.
 - (a) Plus/minus 1 percent at 20-40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
 - 3) Scaling: 0-100 percent RH.
 - d. Hysteresis: 1.5 percent typical.
 - e. Linearity: Included in accuracy specification.
 - f. Reset Rate: 24 hours.
 - g. Stability: Plus/minus 1 percent @ 68 degrees F (20 degrees C) annually, for two years.
- C. Static Pressure (Air Pressure) Sensors:
1. Manufacturers:
 - a. Trane USA_____. www.trane.com
 2. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 3. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 4. Accuracy: One percent of full scale with repeatability 0.3 percent.
 5. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation (Current) Sensors:
1. Manufacturers:
 - a. Trane USA_____. www.trane.com
 2. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.

3. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 4. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- F. Carbon Dioxide Sensors, Duct and Wall:
1. Manufacturers:
 2. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO₂ sensors with integral transducers and linear output.
 - a. Linear, CO₂ Concentration Range Display: 0 to 2000 / 5000 ppm, programmable.
 - b. Accuracy: Plus/minus 30 ppm or plus/minus 2 percent of measured value, measured at NTP.
 - c. Repeatability: Plus/minus 20 ppm or plus/minus 2 percent of measured value.
 - d. Response Time: Less than 60 seconds for 90 percent step change.
 - e. Output:
 - 1) Analog: 4-20 mA.
 - 2) Communication Protocol: Modbus or BACnet.
 - (a) Connection: 2-wire, RS-485.
 - (b) Data Rate: 9600 bps.
 - (c) Parity: None.
 - 3) Wireless: Wi-Fi network.
 3. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 - c. User calibratable with a minimum calibration interval of 5 years.
 4. Construction:
 - a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
 - b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - c. Housing: High impact plastic, UL 94 VO.

2.08 TRANSMITTERS

- A. Building Static Pressure Transmitter:
1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Pressure Transmitters:
1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- C. Air Pressure Transmitters:
1. General: Provide dry media differential pressure transducers to monitor duct and room pressure.
 - a. Media Compatibility: Dry air.
 - b. Input Power: Class 2; 12-30 VDC; 2 - wire: 20 mA max.
 - c. Output: Field selectable, 2-wire, loop-powered 4-20 mA (DC only, clipped & capped).
 - d. Pressure Ranges: 4 and 7, field selectable.
 - e. Response Time:
 - 1) Fast: T₉₅ in 2 seconds.
 - 2) Switch selectable.
 - f. Mode: Switch selectable, unidirectional.
 - g. Display:
 - 1) Signed 3-1/2 digit LCD, indicates pressure.
 - 2) Overrange indicator.

- h. Proof Pressure (pressure differential): 3 psid.
 - i. Burst Pressure (pressure differential): 5 psid.
 - j. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
 - k. Temperature Effect (per transmitter size):
 - 1) 1 inch w.c.: 2.0 percent per degree C.
 - 2) 10 inch w.c.: 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
 - l. Zero Drift (1-year) (per transmitter size):
 - 1) 1 inch w.c.: 2 percent maximum.
 - 2) 10 inch: 0.05 percent maximum.
 - m. Zero adjust: Pushbutton auto-zero & digital input (2-pos terminal block).
 - n. Operating Environment:
 - 1) 32 degrees F to 140 degrees F.
 - 2) 0 to 90 percent RH noncondensing.
 - o. Fittings:
 - 1) Brass barb.
 - 2) 0.24 inches outer diameter.
 - 3) UL 94 V-O fire retardant ABS.
- D. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):
1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.
 - a. Input Power: Class 2; 15 to 30 VDC, 24VAC nominal, 50/60 Hz.
 - b. Maximum Current Draw:
 - 1) DC: 125 mA.
 - c. Output: 3-wire transmitter; user-selectable 4-20 mA/0-5V/0-10V.
 - d. Sensor:
 - 1) Media Compatibility: 17 - 4 PH stainless steel.
 - 2) Status Indication: Dual color LED.
 - 3) Proof Pressure: 2x max. F.S. range.
 - 4) Burst Pressure: 5x max. F.S. range.
 - 5) Accuracy at 77 degrees F for less than or equal 20 ft:
 - (a) Ranges A and B: Plus/minus 1 percent F.S. typical.
 - 6) Surge Damping: Electronic; 1 second averaging.
 - 7) Long Term Stability: Plus/minus 0.25 percent.
 - 8) Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - e. Reverser:
 - 1) Zero Adjust: Push button auto-zero and digital input (2-position terminal block).
 - 2) Fittings:
 - (a) 27 NPT female thread, stainless steel 17 - 4 PH.
 - f. Pressure Ranges:
 - 1) 0 psi to 50 psi (Gauge): 5 psid/10 psid/25 psid/50 psid (pressure differential).
 - g. Operating Conditions:
 - 1) Temperature Compensated Range:
 - (a) 32 degrees F.
 - (b) TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
 - 2) Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
 - 3) Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
 - h. Enclosure: NEMA 250, Type 4.

2.09 TRANSDUCERS

- A. Electropneumatic:

1. General: Provide electropneumatic pressure transducer utilizing micro-controlled poppet valve technology for pressure sensing in multiple applications.
 - a. Input Power: Class 2; 24 VAC/DC nominal, 30 VAC max; 150 mA max.
 - b. Input Impedance: 4-20 mA, 250 ohms; 0-5 V/0-10 VDC; jumper selectable.
 - c. Alarm Contact: 100 mA@30 VAC/DC (Pressure loss, manual mode, jumper selectable).
 - d. Accuracy: 1 percent.
 - e. Compensated Temperature Range: 25 degrees F to 140 degrees F.
 - f. Temperature Coefficient: Plus/minus 0.118 percent per degree F.
 - g. Operating Environment: 10 - 90 percent RH noncondensing.
 - h. Control Range: 0 - 20 psi, or 3 - 15 psi.
 - i. Pressure Differential: 0.1 psi (supply to branch).
 - j. Pressure Indication: Electronic, 3-1/2 digit LCD.
 - k. Minimum Tubing Length: 15 ft.
 - l. Port Connection: 1/8 inch poly tubing.
 - m. Media Connection:
 - 1) Clean, dry air, or inert gas.
 - 2) Use with oxygen service is prohibited.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats. Refer to Section 26 2726.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide guards on thermostats in entrances.
- G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- H. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb/hr with 1/3 - 2/3 load capacities sequenced with smaller valve opening first.
- I. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
- J. Provide isolation (two position) dampers of parallel blade construction.

- K. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- N. Provide conduit and electrical wiring in accordance with Section 26 2717. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION 23 0913

