



23 09 00 – Instrumentation and Control For HVAC

DIVISION 23 – Heating, Ventilating, and Air Conditioning

STATEMENT OF PURPOSE & BACKGROUND

- Guidelines for selection and specification of proven instruments and control devices for HVAC.
- Revision history of section:
 - 10/28/2022 (date of adoption)

OUTLINE SPECIFICATION

- See the Specification Section that follows this cover sheet and incorporate into the Project Manual.

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

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.

1.02 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections:
 - 1. Section 23 05 53 Identification for HVAC Piping and Equipment
 - 2. Section 23 09 23 Direct Digital Control (DDC) System for HVAC
 - 3. Section 23 21 16 Hydronic Piping Specialties
 - 4. Section 23 22 16 Steam and Condensate Piping Specialties
 - 5. Section 23 23 00 Refrigerant Piping

1.03 SUBMITTALS

- A. Product Data: For each type of product include the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation, operation and maintenance instructions including factors effecting performance.
 - 5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - 6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
 - 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

1.04 WARRANTY

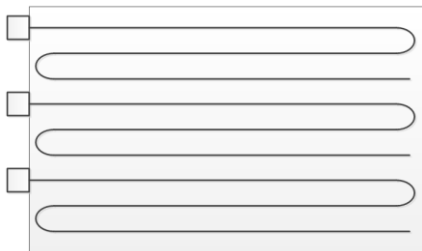
- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
3. Warranty service shall occur during normal business hours and commence within four hours of Owner's warranty service request.
4. Warranty Period: one year from date of Substantial Completion.

PART 2 PRODUCTS (INPUT AND OUTPUT CONTROL DEVICES)

2.01 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor or RTD Temperature Sensors and Transmitters:
 1. Manufacturers:
 - a. DDC Control System Manufacturer's Brand.
 - b. Kele.
 - c. ACI.
 - d. BAPI.
 - e. MAMAC.
 - f. Belimo Inc.
 2. Accuracy: Plus or minus 0.5°F at calibration point.
 3. Drift: Less than 0.25°F over 5 years.
 4. Insertion Elements in Ducts: Single point, of sufficient length to measure near center of duct to a maximum of 18 inches long.
 5. Averaging Elements in Ducts: Minimum 18 feet long bendable copper or aluminum elements mounted across duct in a serpentine fashion with bends in a smooth arc using appropriate fastening hardware as shown. Install and average multiple sensors as required for a maximum spacing of 18" (a minimum of 1 foot of sensor for every 1.5 square feet of duct area).



6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor: Color and style to match architecture with insulated back.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- C. Humidity Sensors (Specifically for ERU frost control, located in the exhaust airstream):
 1. Manufacturers:
 - a. Vaisala.

2. Vaisala HMD60/70 model. Any proposed substitutions shall require a written letter from manufacturer stating the sensor can recover from multiple, sustained saturation and freezing conditions without affecting accuracy.
 3. Accuracy: 2% for minimum of two years.
 4. Duct Sensor Range: 0% to 100% relative humidity.
 5. Duct Sensor Enclosure: IP65 (NEMA 4) housing.
- D. Humidity Sensors (Other than for ERU frost control): Bulk polymer or ceramic substrate sensor element.
1. Manufacturers:
 - a. DDC Control System Manufacturer's Brand.
 - b. ACI.
 - c. BAPI.
 - d. MAMAC.
 - e. Vaisala.
 - f. Belimo Inc.
 2. Accuracy: 3% for minimum of two years.
 3. Room Sensor Range: 10% to 90% relative humidity.
 4. Room Sensor: Color and style to match architecture with insulated back.
 5. Duct Sensor: Single point, inserted at least 4 inches.
 6. Outside-Air Sensor: Watertight inlet fitting, shielded from direct sunlight, measuring range for operation at outdoor temperatures of -40°F to 120°F.
- E. Pressure Transmitters/Transducers:
1. Manufacturers:
 - a. Dwyer.
 - b. Setra.
 - c. ACI.
 - d. BAPI.
 - e. Belimo Inc.
 - f. Veris.
 2. Pressure Transmitter: sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 0.5% of full scale with repeatability of 0.5%.
 - b. Output: linear
 - c. Building or Zone Pressure Range: -0.10 to +0.10 in. wc.
 - d. Duct Static Pressure Range: 0 to 5 in. wc.
 3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service, minimum 150 psig operating pressure, linear output.
 4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150 psig operating pressure and tested to 300 psig; linear output.
 - a. A premanufactured bypass valve assembly shall be required with installation of each water differential-pressure transducer. Bypass valve assembly shall facilitate installation, maintenance, calibration, and verification of sensor.
 - 1) Basis of design: Veris Industries AA14A
 5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
- F. Current Transmitters/Transducers:

1. Manufacturers:
 - a. ACI.
 - b. Veris.
 - c. Kele.
2. Accuracy: 2% of full scale.
3. Sizing: Full scale of sensing device must not be more than 10x the design current of the motor.

2.02 STATUS SENSORS

- A. Pressure Safeties for Fans: Differential-pressure switch, manual reset type with pilot-duty rating and with adjustable range of 0 to 5 in. wc.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Freezestat auto reset type with two isolated sets of contacts. Temperature of any 12" section of sensing element may actuate device. Sensing range minimum scale: 35°F to 45°F. Install with identical requirements to duct temperature averaging type sensor, where it may be required to install multiple device to adequately cover area.
- D. Voltage Monitor: 3-phase type with fixed-trip delay output contact. Protection of three-phase motors against single phasing, low voltage, phase reversal and voltage unbalance.
- E. Current Switches: Self-powered, solid-state, selected to match current and system output requirements.
- F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2-10 VDC feedback signal.
- G. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.
- H. Water Flow Switch: Paddle flow switch with adjustable setpoint and appropriately sized for application. Materials shall be compatible with monitored fluid.
- I. Moisture Sensor Switch: Condensation sensing switch to be mounted on pipes from ½" to 3" OD. For chilled beam and other sensible only cooling applications where condensation may be a problem.
 1. Manufacturers:
 - a. Consense Corporation - CG2-CM-P
 - b. Belimo Inc. - 22HH-50
- J. Condensate High Level Switch: High water level switch to be mounted on coil drain pans, either on a clip on the side of the pan or through the bottom of the pan.
 1. Manufacturers:
 - a. FPI Sensors - LS-1000-SS
 - b. FPI Sensors - SM-1000-SS

2.03 GAS DETECTION EQUIPMENT

- A. Carbon Monoxide Sensor (CO):
 - 1. Manufacturers
 - a. Senva Sensors
 - 2. Electrochemical sensor with a 5-year minimum life and field replaceable sensing elements. Sensor shall include a relay output as well as either an analog output or BACnet communication.
- B. Carbon Dioxide Sensor (CO₂):
 - 1. Manufacturers
 - a. Vaisala.
 - b. Approved equal.
 - 2. GMW80 series, second generation CARBOCAP® technology sensors with a 15-year minimum life; suitable over a temperature range of 32°F to 122°F and calibrated for accuracy of plus or minus 15 ppm over the first five years, for wall mounting

2.04 FLOW MEASURING DEVICES

- A. Water Flow Sensor:
 - 1. Manufacturers
 - a. Onicon, Inc.
 - 2. Technology
 - a. Ultrasonic sensor with an accuracy of 1%.
 - b. Electromagnetic sensor with an accuracy of 1% from 2 to 20 ft/sec.
 - c. Dual turbine sensor with an accuracy of 1% from 3 to 30 ft/sec.
 - 3. Sensor must be located such that there are appropriate numbers of pipe diameters up and down stream of sensor to ensure laminar flow. Follow manufacturer recommendation.
 - 4. Sensor shall be sized and scaled appropriately for specific application.
- B. Air Flow Sensor:
 - 1. Manufacturers
 - a. Ebtron, Inc.
 - 2. Gold Series thermal dispersion airflow sensor with industrial grade integrated transmitter with two analog outputs. Accuracy of 2%, suitable over a temperature range of -20°F to 160°F.
 - 3. Air flow station locations shall be determined by manufacturer's representative to ensure proper operation.
- C. Electric Meter:
 - 1. Manufacturers
 - a. EKM Metering
 - b. Dent Instruments
 - 2. Electric meter with current transducers shall be appropriately sized for full load of equipment being monitored.
 - 3. Shall include a pulse output representing energy consumption with an adjustable scale, or an analog output representing instantaneous power consumption with an adjustable scale.

2.05 BTU METERS

- A. Water BTU Meters:
 - 1. Manufacturers
 - a. Onicon, Inc.
 - 2. Follow requirements of Water Flow Sensor above.

2.06 ACTUATORS

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers:
 - a. Belimo Inc.
 - b. Honeywell, Inc.
 - c. Johnson Controls, Inc.
 - d. Siemens USA.
 - e. Schneider Electric.
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque of 7 in.lbs/sq.ft at 1 in. wc. If operating conditions exceed 3 in. wc, multiply torque by 2.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 - 7. Power Requirements: All actuators to be powered by 24 VAC.
 - 8. Proportional Signal: 0(2) to 10 VDC or 4 to 20 mA, and 0(2) to 10 VDC position feedback signal (if required).
 - 9. Temperature Rating: -22°F to 122°F Temperature Rating.
 - 10. Run Time: Maximum of 100 seconds

2.07 CONTROL VALVES

- A. Manufacturers:
 - 1. Belimo Inc.
 - 2. Honeywell, Inc.
 - 3. Johnson Controls, Inc.
 - 4. Siemens USA.
- B. Usage with Actuator:
 - 1. Provide electronic actuators on all control valves unless noted otherwise.
 - 2. Whenever possible, provide a valve and actuator assembly from factory.
 - 3. Fail-safe operation, spring-return or electronic capacitor. Provide for the following applications, as well as any other applications as noted in the sequences:
 - a. AHU/RTU with heating water, glycol, or steam coil.
 - b. Cabinet unit heaters and unit heaters.
- C. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

- D. Ball Valves (Low Pressure Steam): Equal percentage ball valves with characterized disc.
1. Construction: Brass body, stainless steel trim, EPDM o-rings, thermal break between valve and actuator.
 2. Rating: Rated for steam usage, 250°F operating conditions.
 3. Sizing: Pressure drop based on operating pressure of steam system and design flow rate.
 4. Connection: Threaded
- E. Globe Valves (Low Pressure Steam): Equal percentage globe valves
1. Construction: Cast iron body, stainless steel components and trim, EPDM packing, thermal break between valve and actuator.
 2. Rating: 200 psig body rating, 250°F operating conditions, 100 psid (2-way) or 50 psid (3-way) close-off pressure, rated for steam usage.
 3. Sizing: Pressure drop based on operating pressure of steam system and design flow rate.
 4. Connection: 2" and smaller shall be threaded, 2-1/2" and larger shall be flanged.
- F. Ball Valves (Water): Equal percentage ball valves with characterized disc.
1. Construction: Brass body, brass or stainless steel trim, EPDM o-rings.
 2. Rating: 200 psig body rating, 200°F operating conditions, 100 psid close-off pressure.
 3. Sizing: 5 psig maximum pressure drop at design flow rate.
 4. Connection: 2" and smaller shall be threaded, 2-1/2" and larger shall be flanged.
- G. Pressure-independent Ball Valves (Water): Equal percentage ball valves with characterized disc and integrated pressure regulation.
1. Construction: Brass body, brass or stainless steel trim, EPDM o-rings
 2. Rating: 200 psig body rating, 200°F operating conditions, 100 psid close-off pressure.
 3. Sizing: Round up from design flow rate to ensure sufficient flow.
 4. Connection: 2" and smaller shall be threaded, 2-1/2" and larger shall be flanged.
- H. Butterfly Valves (Water): Equal percentage butterfly valve.
1. Usage: Only permitted for 2-1/2" or larger valves used in two-position applications, such as boiler/chiller isolation or dry-cooler switchover.
 2. Construction: Stainless disc, ductile iron body, EPDM liner
 3. Rating: 232 psig body rating, 250°F operating conditions, 150 psid close-off pressure.
 4. Sizing: 5 psig maximum pressure drop at design flow rate.
- I. Globe Valves (Water): Equal percentage globe valve.
1. Usage: Only permitted for 2-1/2" or larger valves used in two-position applications, such as boiler/chiller isolation valves or changeover valves.
 2. Construction: Bronze body, stainless steel trim, EPDM disc.
 3. Rating: 200 psig body rating, 200°F operating conditions, 100 psid close-off pressure.
 4. Sizing: 5 psig maximum pressure drop at design flow rate.

2.08 CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company
 - 2. TAMCO, Inc.
 - 3. Nailor Industries, Inc.
 - 4. Johnson Controls, Inc.

- B. Pressure and Volume Control Dampers
 - 1. Construction: Aluminum airfoil blades, synthetic or bronze bearings, zinc-plated stainless steel axels and linkages.
 - 2. Rating: -40°F to 150°F, 3000 fpm at 3.5 in. wc.
 - 3. Leakage: AMCA Class IA, 3 cfm/sq.ft at 1 in. wc.
 - 4. Blade Configuration: Parallel blade for modulating applications, opposed blade for two-position applications.
 - 5. Sizing: Coordinate sizing with mechanical contractor.

2.09 RELAYS

- A. General-Purpose Relays
 - 1. Relays shall be heavy duty and rated for at least 10 A at 240 VAC and 60 Hz.
 - 2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
 - 3. Use a plug-in-style relay with industry-standard, 35 mm DIN rail socket.
 - 4. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated pin numbers.
 - 5. Construct the contacts of either silver cadmium oxide or gold.
 - 6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
 - 7. Relays shall have LED indication.
 - 8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 30 ms or less.
 - d. Dropout Time: 310 ms or less.
 - e. Pull-in Voltage: 85% of rated voltage.
 - f. Dropout Voltage: 50% of nominal rated voltage.
 - g. Power Consumption: 2 VA or less.
 - h. Ambient Operating Temperatures: -40°F to 115°F

2.10 PUSH BUTTONS (SHUTOFF)

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Provide with clear cover that is ADA compliant (<4" deep).
 - 2. Provide with custom labels to indicate device purpose "BOILER SHUTOFF", "EPO", etc.
 - 3. Push to activate, turn to reset.
 - 4. Provide with horn where it is critical that it is only used in an emergency.
 - 5. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- a. Safety Technology International (STI) SS-2341.
- b. Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

- A. Connect and configure equipment and software to achieve sequence of operation specified.
- B. Verify location of temperature sensors, thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install all devices with manual adjustment at 48 inches above the floor to comply with ADA. Install all devices without manual adjustments, sensors at 48 inches above the floor.
- C. Use flat plate sensors or install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated.
- D. Where temperature sensors are installed on exterior walls, use the following installation practice to minimize the influence of outside conditions on sensor reading.
 - 1. Provide 2-inch deep wall box, filled with insulation, so that sensor is mounted 2-inches off the surface of wall.
 - 2. Provide ¼" thick, closed-cell foam insulation between sensor and wall box with a small slit to allow only wiring to pass through. Foam insulation shall provide a tight seal to prevent infiltration air from spilling over sensing element.
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Section 23 05 53 Identification for HVAC Piping and Equipment.
- G. Install hydronic instrument wells, valves, and other accessories according to Section 23 21 16 Hydronic Piping Specialties.
- H. Install steam and condensate instrument wells, valves, and other accessories according to Section 23 22 16 Steam and Condensate Piping Specialties.
- I. Install refrigerant instrument wells, valves, and other accessories according to Section 23 23 00 Refrigerant Piping.
 - 1. Location that is easily accessible by operators.
 - 2. Top of controller shall be within 84 inches of finished floor.

END OF SECTION