

## SECTION 15900 – HVAC INSTRUMENTATION AND CONTROLS

### PART 1 - GENERAL

- 1.1 **NOTE:** *Low voltage conduit, raceways, boxes, cabinets, wire and cable shall be furnished and installed within the scope of HVAC Instrumentation and Controls. Line voltage power shall be furnished and installed within the scope of Division 16.*

### 1.2 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. See Division 13 Section "Fire Alarm" for fire and smoke detectors mounted in HVAC systems and equipment.

### 1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
  - 3. Details of control panel faces, including controls, instruments, and labeling.
  - 4. Schedule of dampers including size, leakage, and flow characteristics.
  - 5. Schedule of valves including leakage and flow characteristics.
- C. Field quality-control test reports.
- D. Operation and maintenance data.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- D. Year-2000 Compliant: Computer hardware and software shall be capable of accurately processing, providing, and receiving date data from, into, and between the twentieth and twenty-first centuries, including leap-year calculations.

## **1.5 COORDINATION**

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 13 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 16 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

## **1.6 EXTRA MATERIALS**

- A. Maintenance Materials: Four (4) thermostat adjusting keys.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Alerton.

### **2.2 CONTROL PANELS**

- A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled. Ethernet Router:
  - 1. Enclosure: Aluminum
  - 2. Power: 24VAC, 7.2VA, 60 Hz
  - 3. Communication: BACnet 802.3 SAP 82 port
  - 4. Network: supports 98 control modules
  - 5. Support: BACnet interoperability Building Blocks – data sharing, alarm and event management, scheduling, trending, device and network management
  - 6. Ethernet Port: 10Base-T over twisted pair using an RJ45 connector @ 10M baud
  - 7. ARCNET Port: 156K baud over twisted pair (screw terminals)
  - 8. Access Port: 38.4K baud 8-pin mini-DIN
  - 9. Memory: 2 MB RAM, 1 MB Flash

10. Dimensions: 7 1/8"w x 6"h x 2 3/4"d, 1.6 lbs.
  11. Automated Logic #LGE
- B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels. Control Modules:
1. Enclosure: NEMA 3R
  2. Power: 24VAC, 20.0VA, 60 Hz
  3. Communication: BACnet over ARCNET 156K baud
  4. Microprocessor: 32-bit Motorola MC68-series
  5. Memory: 512 K Bytes RAM, 512 K Bytes Flash
  6. Clock: real time, battery-backed
  7. Operating Environment: -20°F to 150°F, 10-95% RH non-condensing
  8. Digital Outputs: Six (6) 3A @ 24VAC, LED indication
  9. Universal Inputs: Ten (10) 0-5VDC, 2-20mA
  10. Resolution: 10-bit A/D
  11. Input Pulse Frequency: 10Hz
  12. Analog Outputs: Four (4) 0-10VDC, 0-20mA, LED indication
  13. Resolution: 8-bit D/A
  14. Dimensions: 8 7/8"w x 7 1/2"h x 2 3/4"d Automated Logic #S-Line
1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
  2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
  3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
  4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
- B. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
1. Alarm Condition: Indicating light flashes and horn sounds.
  2. Acknowledge Switch: Horn is silent and indicating light is steady.
  3. Second Alarm: Horn sounds and indicating light is steady.
  4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
  5. Contacts in alarm panel allow remote monitoring by independent alarm company.

## **2.3 ANALOG CONTROLLERS**

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

## **2.4 TIME CLOCKS**

- A. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
- B. Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

## **2.5 SENSORS**

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
  - 1. Thermistor temperature sensors as follows:
    - a. Accuracy: Plus or minus 0.5 deg F at calibration point.
    - b. Wire: Twisted, shielded-pair cable.
    - c. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
    - d. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
    - e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
    - f. Room Sensors: Match room thermostats, locking cover.
    - g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
    - h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
  - 2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    - b. Output: 4 to 20 mA.
    - c. Building Static-Pressure Range: 0 to 0.25 inch wg.
    - d. Duct Static-Pressure Range: 0 to 5 inches wg.

3. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- B. Equipment operation sensors as follows:
1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
  2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
  3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- D. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 130 deg F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.
- E. 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.

## **2.6 THERMOSTATS**

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.
1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.
- B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.
- C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
  2. Dead Band: Maximum 2 deg F.
- D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
  2. Bulbs in air ducts with flanges and shields.
  3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
  4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
  5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.

6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, with the following:
  1. Reset: Manual.
- F. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
  1. Set-Point Adjustment: Concealed.
  2. Set-Point Indication: Exposed.
  3. Thermometer: Concealed.
  4. Color: White
  5. Orientation: Vertical.
- G. Room thermostat accessories include the following:
  1. Insulating Bases: For thermostats located on exterior walls.
  2. Adjusting Key: As required for calibration and cover screws.
  3. Aspirating Boxes: For flush-mounted aspirating thermostats.
  4. Set-Point Adjustment: 1/2-inch diameter, adjustment knob.
- H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- I. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
  1. Bulb Length: Minimum 20 feet.
  2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- J. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
  1. Bulb Length: Minimum 20 feet .
  2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

## **2.7 ACTUATORS**

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
- B. Electronic Damper Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
  1. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
  2. Dampers: Size for running torque calculated as follows:

- a. Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
  - b. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
  - c. Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. of damper.
  - d. Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
  - e. Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
  - f. Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2500 to 3000 FPM: Multiply the minimum full-stroke cycles above by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
  4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
  6. Power Requirements (Two-Position Spring Return): 24 V ac.
  7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  9. Temperature Rating: [Minus 22 to plus 122 deg F.
  10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
  11. Run Time: 30 seconds.

## **2.8 DAMPERS**

- A. Dampers: AMCA-rated, parallel blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.
  1. Blades shall be secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
  2. Operating Temperature Range: From minus 40 to plus 200 deg F.
  3. For standard applications, include optional closed-cell neoprene edging.
  4. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

## **2.9 CONTROL CABLE**

- A. Electronic Cable for Control Wiring: As specified in Division 16 Section "Control/Signal Transmission Media."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install equipment level and plumb.

- B. Verify location of thermostats, and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- C. Install guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Public areas.
  - 3. Where indicated.
- D. Install automatic dampers according to Division 15 Section "Duct Accessories."
- 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 Division 15
- G. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.
- H. Install electronic cables according to Division 16 Section "Control/Signal Transmission Media."

### **3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."
- B. Install building wire and cable according to Division 16 Section "Conductors and Cables."
- C. Install signal and communication cable according to Division 16 Section "Control/Signal Transmission Media."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

### **3.3 CONNECTIONS**

- A. Install piping adjacent to machine to allow service and maintenance.
- B. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- C. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.



- D. Ground equipment.

### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
  - 3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Engage a factory-authorized service representative to perform startup service.
- C. Replace damaged or malfunctioning controls and equipment.
  - 1. Start, test, and adjust control systems.
  - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
  - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

### **3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1.

### **3.6 ON-SITE ASSISTANCE**

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project-site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

**END OF SECTION 15900**