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**SECTION 23 09 13**  
**INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Control panels.
- B. Control Valves:
  - 1. Ball valves and actuators.
  - 2. Electronic operators.
- C. Pressure independent valves and actuators.
- D. Dampers.
- E. Damper Operators:
  - 1. Electric operators.
- F. Humidistats:
  - 1. Room humidistats.
- G. Input/Output Sensors:
  - 1. Temperature sensors.
  - 2. Humidity sensors.
  - 3. Static pressure (air pressure) sensors.
  - 4. Equipment operation (current) sensors.
- H. Thermostats:
  - 1. Electric room thermostats.
  - 2. Low-limit temperature cutout switch (freezestat)
  - 3. Line voltage thermostats.
  - 4. Room thermostat accessories.
  - 5. Outdoor reset thermostats.
  - 6. Immersion thermostats.
  - 7. Airstream thermostats.
  - 8. Electric low limit duct thermostats.
  - 9. Electric high limit duct thermostats.
- I. Transmitters:
  - 1. Building static pressure transmitters.
  - 2. Temperature transmitters.
- J. Fire Fighter's Smoke Control Panel

**1.2 RELATED REQUIREMENTS**

- A. Section 22 05 19 - Meters and Gauges for Plumbing Piping: Thermometer sockets and gauge taps.
- B. Section 23 21 13 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, and gauge taps.
- C. Section 23 21 14 - Hydronic Specialties.
- D. Section 23 33 00 - Air Duct Accessories: Installation of automatic dampers.
- E. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

**1.3 REFERENCE STANDARDS**

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- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating 2018.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage 2021.
- C. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- E. ASTM B32 - Standard Specification for Solder Metal 2020.
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- H. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats 2013.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.

#### **1.4 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.

#### **1.5 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- C. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, marked up to identify the items to be used on the project.
- D. 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.
- E. 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.
- F. Manufacturer's Instructions: Provide for all manufactured components.
- G. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- H. 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.
- I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Extra Thermostats and Other Exposed Sensors: One of each type.

#### **1.6 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

#### **PART 2 PRODUCTS**

**2.1 MANUFACTURERS**

- A. Schnieder Electric.

**2.2 EQUIPMENT - GENERAL**

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

**2.3 CONTROL PANELS**

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels. Coordinate lock type with Covanta key system.

**2.4 FIRE FIGHTER'S SMOKE CONTROL PANEL**

- A. Fire Fighter's Smoke Control Panel shall be constructed in accordance with NFPA 72. All components shall be UL 864 listed.
- B. Fire Fighter's Control Panel shall be manufactured by Automation Display Inc. or approved equal.
- C. See drawings for a list of items to be controlled and displayed on the Fire Fighter's Control Panel.

**2.5 CONTROL VALVES**

- A. Ball Valves and Actuators:
  - 1. Manufacturers:
    - a. Belimo Aircontrols (USA), Inc: [www.belimo.com/#sle](http://www.belimo.com/#sle).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  - 2. Service: Use for hot water.
  - 3. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
  - 4. Replacements in Kind: Provide pressure-independent type.
  - 5. Rangeability: 500 to 1.
  - 6. ANSI Rating: Class 150.
  - 7. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
  - 8. Body Size:
    - a. Under 2-1/2 inches:
      - 1) Connection: NPT.
      - 2) Materials:
        - (a) Body: Brass.
        - (b) Flanges: Ductile iron.
        - (c) Ball: Chrome-plated brass.
        - (d) Stem: Nickel-plated brass.
        - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
        - (f) Stem Seal: EPDM O-Rings.
        - (g) Flow Control Disk: Thermoplastic synthetic-resin.
    - b. Service Temperature:

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- 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
  - 2) Ambient Side: From minus 4 to 122 degrees F.
9. Actuator Requirements:
    - a. Assembly: Factory-mounted.
    - b. Input: 0 to 5 VDC configured for proportional control.
    - c. Accessories: Provide with valve position indicator and manual override.
  - B. Ball Valve:
    1. Bronze body, stainless steel, 3 piece, full port
      - a. Product:
        - 1) Substitutions: See Section 01 6000 - Product Requirements.
    2. Hydronic Systems:
      - a. Rate for service pressure of 125 psig at 250 degrees F.
      - b. Stainless steel ball.
      - 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.
    3. Steam Systems:
      - a. Rate for service pressure of 125 psig at 250 degrees F.
      - b. 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.
  - C. Electronic Operators:
    1. Manufacturers:
      - a. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
    2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
    3. Select operator for full shut off at maximum differential pressure.
    4. Coordinate voltages with installation and contractor responsible for wiring device.
    5. End switch.
    6. Fully modulating or 2-position as required.

## **2.6 DAMPERS**

- A. Manufacturers:
    1. Ruskins.
    2. Substitutions: See Section 01 60 00 - Product Requirements.
  - B. Performance: Test in accordance with AMCA 500-D.
  - C. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch.
  - D. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gauge, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
  - E. Blade Seals: Neoprene mechanically attached, field replaceable.
  - F. Jamb Seals: Spring stainless steel.
  - G. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.
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- H. Maximum Pressure Differential: 6 inches wg.
- I. Temperature Limits: Minus 40 to 200 degrees F.

## **2.7 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.
- B. Electric Operators:
  - 1. Manufacturers:
    - a. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  - 2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

## **2.8 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.

## **2.9 INPUT/OUTPUT SENSORS**

- A. Temperature Sensors:
  - 1. Manufacturers:
    - a. Schnieder Electric.
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  - 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. Temperature Sensing Device: Compatible with project DDC controllers.
  - 5. 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. Thermistor:
      - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
      - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
      - 3) Heat Dissipation Constant: 2.7 mW per degree C.

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- c. Temperature Transmitter:
    - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
    - 2) Output: 4 to 20 mA.
  - d. Sensing Range:
    - 1) Provide limited range sensors if required to sense the range expected for a respective point.
  - e. 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.
  - f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
  - g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
  - h. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
  - i. Room Temperature Sensors:
    - 1) Construct for wall box mounting.
    - 2) Provide the following:
      - (a) Setpoint reset slide switch with an adjustable temperature range.
      - (b) Individual heating/cooling setpoint slide switches.
      - (c) Momentary override request push button for activation of after-hours operation.
      - (d) Analog thermometer.
  - j. Room Temperature Sensors with Integral Digital Display:
    - 1) Construct for wall box.
    - 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.
  - k. Temperature Averaging Elements:
    - 1) Use on duct sensors for ductwork 10 sq ft or larger.
    - 2) Use averaging elements where prone to stratification with sensor length 8 ft.
    - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
  - l. Insertion Elements:
    - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
    - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Humidity Sensors:
- 1. Manufacturers:
    - a. Schnieder Electric.
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Static Pressure Sensors:
- 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
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2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
  3. Accuracy: One percent of full scale with repeatability 0.3 percent.
  4. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation Sensors:
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 psi.
  3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
  4. Product:
    - a. Substitutions: See Section 01 6000 - Product Requirements.
- E. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- F. Static Pressure (Air Pressure) Sensors:
1. Manufacturers:
    - a. Schnieder Electric.
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  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 to 5 vdc with power at 12 to 28 vdc.
- G. Equipment Operation (Current) Sensors:
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 psi.
  3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

## **2.10 THERMOSTATS**

- A. Electric Room Thermostats:
1. Manufacturers:
    - a. Schnieder Electric.
  2. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
  3. Service: Cooling and Heating; one step cooling and two step heating.
  4. Covers: Locking with set point adjustment, with thermometer.
- B. Low-Limit Temperature Cutout Switch (low-limit thermostat or freezestat):
1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  2. Configuration: Digital module tied to sensor-assembly.
  3. Sensing Length: 4 feet.
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4. Setpoint Adjust: Slider.
  5. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
  6. Mounting: Locate on cooling coil intake side.
  7. Field Interface: Connect load line-voltage to stater.
  8. Electrical Rating: Pilot duty, 125 VA at 125 to 600 VAC.
- C. Line Voltage Thermostats:
1. Integral manual On/Off/Auto selector switch, single or two pole as required.
  2. Dead Band: Maximum 2 degrees F.
  3. Cover: Locking with set point adjustment, with thermometer.
- D. Room Thermostat Accessories:
1. Thermostat Covers: Brushed aluminum.
  2. Insulating Bases: For thermostats located on exterior walls.
  3. Thermostat Guards: Metal mounted on separate base.
  4. Adjusting Key: As required for device.
- E. Outdoor Reset Thermostats:
1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
  2. Scale range: Minus 10 to 70 degrees F.
- F. Immersion Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- G. Airstream Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
  2. Averaging service remote bulb element: 7.5 feet.
- H. Electric Low Limit Duct Thermostats:
1. Snap acting, single pole, single throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint.
  2. Bulb length: Minimum 20 feet.
  3. Provide one thermostat for every 20 sq ft of coil surface.

## **2.11 TRANSMITTERS**

- A. Building Static Pressure Transmitters:
1. One pipe, differential type with temperature compensation, 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. Temperature Transmitters:
1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube
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operation on 20 psig input pressure and 3 to 15 psig output.

D. Humidity Transmitters:

1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

### **PART 3 EXECUTION**

#### **3.1 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.

#### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate voltage and power requirements of each device with installation and contractor responsible for wiring device.
- C. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Locate 42 inches above finished floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.
- D. Mount freeze protection thermostats using flanges and element holders.
- E. Mount outdoor reset thermostats and outdoor sensors indoors with sensing elements outdoors with sun shield.
- F. Provide separable sockets for liquids and flanges for air bulb elements.
- 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 per hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
- I. Provide isolation (two position) dampers of parallel blade construction.
- J. Actuators
  1. Install in an accessible location, with room for actuator removal and service. Adjust the actuator to provide tight shutoff. Provide stem indicator and adjust to indicate proper travel.
  2. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. 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.

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- L. Install "on/off/auto" selector switches to override automatic interlock controls when switch is in "on" position.
- M. Power
1. Power feeds for the building automation system, control panels or to operate the controls shall be fed from a 120 volt panel.
  2. Any breaker indicated as "Building Controls" is available for the controls to furnish and install the associated wiring and conduit in accordance with Section 26 05 83 - Wiring Connections. Electrical material and installation shall be in accordance with appropriate requirements of Division 26. The contractor shall extend power wiring to the location required by the controls device.
  3. If additional circuits or power is required for the Control system, it is the contractors responsibility to provide the breaker, wiring and conduit in accordance with Section 26 05 83 - Wiring Connections. Electrical material and installation shall be in accordance with appropriate requirements of Division 26. The contractor shall extend power wiring to the location required by the controls device.
- N. Wire and Cable
1. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
  2. Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A.
  3. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire to wire connections shall be at a terminal block.
  4. Instrumentation grounding shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system.
  5. Test installed ground rods as specified in IEEE 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings.
- O. Electric Low Limit Duct Thermostat:
1. A temperature limit switch (freezestat) shall be provided to sense the temperature at all outside air connections to mechanical equipment.
  2. A temperature limit switch (freezestat) shall be provided to sense the temperature at all water to air heat transfer mechanical equipment.
  3. A sufficient number of temperature limit switches (freezestats) shall be installed to provide complete coverage of the duct or coil section.
  4. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily.
  5. The temperature limit switch (freezestat) sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.
- P. Duct Static Pressure sensor
1. The duct static pressure sensing tap shall be located at 75% to 100% of the distance between the first and last air terminal units.
  2. If the transmitter output is a 4-20 mA or 0-10Vdc signal, the transmitter shall be located in the same enclosure as the air handling unit (AHU) / Fan or equipment controller for the equipment
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serving the duct system.

### **3.3 ADJUSTING**

- A. The AMD shall not be adjusted to match field measurements without approval from the consulting mechanical engineer when installations meet or exceed manufacturer's suggested placement guidelines. Field adjustment, when required shall be accomplished using transmitter firmware that calculates adjustment gain and offset coefficients based on one or two reference measurements.

### **3.4 MAINTENANCE**

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- D. In addition to normal service calls, make minimum of 2 complete normal inspections of approximately 8 hours duration to inspect, calibrate, and adjust controls.

### **3.5 START-UP**

- A. Perform all startup and commissioning for a complete installation.

### **3.6 TRAINING**

- A. Perform 40 hours training service including three 8 hour on site sessions.

**END OF SECTION 23 09 13**