SECTION 230923.23 - PRESSURE INSTRUMENTS

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

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

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section Includes:

Air-pressure sensors.

Air-pressure switches.

Air-pressure transmitters.

Liquid-pressure switches.

Liquid-pressure transmitters.

* + - * 1. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.23.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.
      1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product, including the following:

Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

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.

Product description with complete technical data, performance curves, and product specification sheets.

Installation instructions, including factors affecting performance.

* + - * 1. Shop Drawings:

Include plans, elevations, sections, and [**mounting**]details.

Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Number-coded identification system for unique identification of wiring, cable, and tubing ends.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Product installation location shown in relationship to room, duct, pipe, and equipment.

Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.

Size and location of wall access panels for instruments installed behind walls.

Size and location of ceiling access panels for instruments installed in accessible ceilings.

Retain "Product Certificates" paragraph below to require submittal of product certificates from manufacturers.

* + - * 1. Product Certificates: For each product requiring a certificate.

Requirements in "Product Test Reports" paragraph below are for test reports for products on which tests are performed either by independent testing agencies or by manufacturers in their own labs. Retain first option below if testing is likely to be performed in manufacturer's facilities and witnessed by a qualified testing agency; retain second option if testing is performed by the testing agency.

* + - * 1. Product Test Reports: For each product requiring test performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].
        2. Source quality-control reports.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1. PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures, see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS
         1. Environmental Conditions:

Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated[**and cooled**], filtered, and ventilated as required by instrument and application.

Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument-installed location shall dictate following NEMA 250 enclosure requirements:

Outdoors, Protected: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.

Outdoors, Unprotected: [**Type 4**] [**Type 4X**] <**Insert type**>.

Indoors, Heated with Filtered Ventilation: [**Type 1**] [**Type 2**] <**Insert type**>.

Indoors, Heated with Nonfiltered Ventilation: [**Type 2**] [**Type 12**] <**Insert type**>.

Indoors, Heated and Air-Conditioned: [**Type 1**] <**Insert type**>.

Mechanical Equipment Rooms:

Chiller and Boiler Rooms: [**Type 12**] [**Type 4**] [**Type 4X**] <**Insert type**>.

Air-Moving Equipment Rooms: [**Type 1**] [**Type 2**] [**Type 12**] <**Insert type**>.

Localized Areas Exposed to Washdown: [**Type 4**] [**Type 4X**] <**Insert type**>.

Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.

Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**] [**Type 4X**] <**Insert type**>.

Hazardous Locations: Explosion-proof rating for condition.

<**Insert location and enclosure requirements**>.

* + - 1. AIR-PRESSURE SENSORS

Retain one of two "Duct Insertion Static Pressure Sensor" paragraphs or "Duct Traverse Static Pressure Sensor" Paragraph below. "Duct Traverse Static Pressure Sensor" Paragraph is best suited for applications requiring high performance.

* + - * 1. Duct Insertion Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9786) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944462).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Model A 301 Series."

Insertion length shall be at [**4 inches (100 mm)**] [**6 inches (150 mm)**] [**8 inches (200 mm)**] [**12 inches (300 mm)**].

Sensor with four radial holes of 0.04-inch (1-mm) diameter.

[**Brass**] [**or**] [**stainless-steel**] construction.

Sensor with threaded end support, sealing washers and nuts.

Connection: NPS 1/4 (DN 6) compression fitting.

Suitable for flat oval, rectangular, and round duct configurations.

* + - * 1. Duct Insertion Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9787) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[MAMAC Systems, Inc](http://www.specagent.com/Lookup?uid=123456944463).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on MAMAC's "Model A-520."

Sensor probe with two opposing orifices designed to reduce error-associated air velocity.

Sensor insertion length shall be [**4 inches (100 mm)**] [**or**] [**8 inches (200 mm)**].

Construct sensor of [**6061-T6 aluminum alloy**] [**or**] [**Type 304 stainless steel**].

Connection: Threaded, NPS 1/8 (DN 6) swivel fitting for connection to copper tubing or NPS 1/4 (DN 10) barbed fitting for connection to polyethylene tubing.

Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.

Mounting flange shall be suitable for flat oval, rectangular, and round duct configurations.

Pressure Rating: 10 psig (69 kPa).

* + - * 1. Duct Traverse Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9788) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944464).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on "Air Monitor's "STAT probe."

Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches (150mm) along length of sensor.

Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.

Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.

Mounting plate with threaded, NPS 3/8 (DN 12) compression fitting for connection to tubing.

Accuracy within 1 percent of actual operating static pressure.

Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30 degree yaw and pitch.

Suitable for velocities of 100 to 10000 fpm (0.51 to 51 m/s) and temperatures of up to 200 deg F (93 deg C).

Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.

Suitable for flat oval, rectangular, and round duct configurations.

Retain one of three "Outdoor Static Pressure Sensor" paragraphs below. Third paragraph has documented performance and is better suited for applications requiring high performance.

* + - * 1. Outdoor Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9789) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944465).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Model A306."

Provides average outdoor pressure signal.

Sensor with no moving parts.

Kit includes sensor, vinyl tubing mounting hardware.

* + - * 1. Outdoor Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9790) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944466).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Model A420."

Provides average outdoor pressure signal.

Sensor with no moving parts.

NEMA 250, Type 4X enclosure.

Pressure Connection: Brass barbed fitting for NPS 1/4¼ (DN 10)tubing.

Conduit fitting around pressure fitting for sensor support and protection to pressure connection.

* + - * 1. Outdoor Static Pressure Sensor:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9791) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944467).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "SOAP."

Sensor with no moving parts.

Operation not affected and impaired by rain and snow.

Sensing plates constructed of 0.1406-inch (3.6-mm) Type 316 stainless steel.

Accuracy within:

1 percent of the actual outdoor atmospheric pressure when subjected to varying horizontal radial wind velocities up to 40 mph.

2 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 30 degrees to horizontal.

3 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 60 degrees to horizontal.

Threaded, PS 2 (DN 50) connection.

Retain one of three "Space Static Pressure Sensor for Wall Mounting" paragraphs below. Third paragraph has documented performance and is better suited for applications requiring high performance.

* + - * 1. Space Static Pressure Sensor for Wall Mounting:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9792) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944468).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Model A420."

100-micron filter mounted in stainless-steel wall plate senses static pressure.

Wall plate provided with gasket and screws, and sized to fit standard single-gang electrical box.

Back of sensor plate fitted with brass barbed fitting for tubing connection.

* + - * 1. Space Static Pressure Sensor for Wall Mounting:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9793) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[MAMAC Systems, Inc](http://www.specagent.com/Lookup?uid=123456944469).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on MAMAC's "Model A523."

White ABS plastic wall plate with integral sensing port to sense static pressure.

Wall plate provided with matching colored screws and sized to fit standard single-gang electrical box.

Back of sensor plate fitted with brass union fitting for tubing connection.

Pressure rating: 10 psig (69kPa).

* + - * 1. Space Static Pressure Sensor for Wall Mounting:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9794) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944470).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "Model SAP/B."

[**Aluminum**] [**Stainless-steel**] wall plate with perforated center arranged to sense space static pressure. Exposed surfaces are provided with brush finish.

Wall plate provided with screws and sized to fit standard single-gang electrical box.

Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch (3-mm) fitting for tubing connection.

Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.

* + - * 1. Space Static Pressure Sensor for Recessed Ceiling Mounting:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9795) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944471).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "Model SAP/R."

[**Aluminum**] [**Stainless-steel**] round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.

Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.

Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch (3-mm) fitting for concealed tubing connection.

Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.

* + - * 1. Space Static Pressure Sensor for Exposed or Suspended Mounting:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9796) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944472).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "Model SAP/S" for surface mounted or its "Model SAP/P" for suspended mount.

Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.

[**Aluminum**] [**Stainless steel**] with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.

Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.

Retain first two paragraphs below for surface-mounted sensors.

Surface-mounted sensor provided with solid mounting plate intended for mount to ceiling with pressure chamber exposed to view.

Surface-mounted sensor with 0.125-inch (3-mm) fitting for exposed tubing connection.

Retain first two paragraphs below for suspended sensors.

Suspended sensor intended for pendent mount with pressure chamber exposed to view.

Suspended sensor with NPS 1/2 (DN 15) fitting for exposed pipe or tubing connection.

* + - 1. AIR-PRESSURE SWITCHES
         1. Air-Pressure Differential Switch:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9797) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944473).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series 1900."

Diaphragm operated to actuate an SPDT snap switch.

Fan safety shutdown applications: Switch with manual reset.

Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Screw-type set-point adjustment located inside removable enclosure cover.

High and Low Process Connections: Threaded, NPS 1/8 (DN 6).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 15 A at 120- to 480-V ac.

Pressure Limits:

Continuous: 45 inches wg (11.2 kPa).

Surge: 10 psig (68.9 kPa).

Temperature Limits: Minus 30 to 180 deg F (Minus 34 to 82 deg C).

Operating Range: Approximately 2 times set point.

Repeatability: Within 3 percent.

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

* + - * 1. Air-Pressure Differential Switch with Set-Point Indicator:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9798) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944474).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series 1630."

Diaphragm operated to actuate an SPDT snap switch.

Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.

High and Low Process Connections: Threaded, NPS 1/8 (DN 6).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 15 A at 120- to 480-V ac.

Pressure Limits:

Continuous: 10 psig (69 kPa).

Surge: 25 psig (172 kPa).

Temperature Limits: Minus 30 to 110 deg F (Minus 34 to 43 deg C).

Operating Range: Approximately 2 times set point.

Repeatability: Within 1 percent.

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

* + - * 1. Air-Pressure Differential Switch with Dual Scale Adjustable Set Point:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9799) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944475).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series ADPS."

Diaphragm operated to actuate an SPDT snap switch.

Electrical Connections: Push-on screw terminals.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Dual scale set-point adjustment knob located inside removable enclosure cover.

High and Low Process Connections: Slip-on tubing connections.

Enclosure:

Dry Indoor Installations: NEMA 250, Type 13.

Operating Data:

Electrical Rating: 1.5 A at 250-V ac.

Pressure Limits: 40 inches wg (10 kPa)

Temperature Limits: Minus 4 to 185 deg F (Minus 20 to 85 deg C).

Operating Range: Approximately 2 times set point.

* + - * 1. Air-Pressure Differential Indicating Switch:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9800) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944476).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Photohelic Series 3000."

Combination gage with low- and high-limit switches.

Nominal 4-inch- (100-mm-) diameter analog indication with white dial face, graduated black markings, pointer to indicate measured value, and a separate adjustable pointer for each switch set point.

Switch zero and set-point [**tamperproof**]adjustment screws or knobs on the dial face.

Each switch used as a safety limit shall have a manual reset button local to switch.

Switch Type: Each set point shall have two Form C relays, DPDT.

Electrical Connections: Screw terminals.

Enclosure Conduit Connection: NPS 3/4 (DN 20) threaded connection.

High and Low Process Connections: Threaded, NPS 1/8 (DN 6).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 10 A at 120- to 240-V ac.

Pressure Limits: 25 psig (172 kPa).

Temperature Limits: 20 to 120 deg F (Minus 7 to 49 deg C).

Operating Range: Approximately twice normal operating range unless otherwise required for application.

Accuracy:

4 percent for ranges through 0.5 in. wg (125 Pa).

2 percent for ranges 1 in. wg (250 Pa) and greater.

Repeatability: Within 1 percent of full scale.

Switch Deadband: One pointer width and within 1 percent of full scale for each switch set point.

Power Supply: [**24**] [**or**] [**120**]-V ac, 50/60 Hz.

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

* + - 1. AIR-PRESSURE TRANSMITTERS

Retain one of first two "Air-Pressure Differential Transmitter" subparagraphs below.

* + - * 1. Air-Pressure Differential Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9801) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Setra System](http://www.specagent.com/Lookup?uid=123456944477).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Setra's "Model 267."

Performance:

Range: Approximately 2 times set point.

Accuracy: Within [**1**] [**0.5**] [**0.4**] [**0.25**] percent of the full-scale range.

Hysteresis: Within 0.10 percent of full scale.

Repeatability: Within 0.05 percent of full scale.

Stability: Within 1 percent of span per year.

Overpressure: 10 psig (69 kPa).

Temperature Limits: Zero to 150 deg F (Minus 18 to 66 deg C).

Compensate Temperature Limits: 40 to 150 deg F (4 to 66 deg C).

Thermal Effects: 0.033 percent of full scale per degree F.

Shock and vibration shall not harm the transmitter.

Output Signals:

Retain only one of first two subparagraphs below to restrict signal options.

Analog Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 800-ohm load.

Analog Voltage Signal:

Three wire, zero to [**5**] [**10**] V.

Minimum Load Resistance: 1000 ohms.

Retain "Display" Subparagraph below for optional display.

Display: Four-digit digital display with minimum 0.4-inch- (10-mm-) high numeric characters.

Operator Interface: Zero and span adjustments located behind cover.

Construction:

Plastic casing with removable plastic cover.

Threaded, NPS 1/4 (DN 10) swivel fittings for connection to copper tubing or NPS 3/16 (DN 7) barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4.

Provide mounting bracket suitable for installation.

* + - * 1. Air Pressure Differential Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9802) Subject to compliance with requirements, provide products by the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123456944478).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Ashcroft's "Model XLDP."

Performance:

Range: Approximately 2 times set point.

Accuracy: Within [**0.25**] [**0.5**] percent of the span at reference temperature of 70 deg F (21 deg C).

Hysteresis: Within 0.02 percent of the span.

Repeatability: Within 0.05 percent of the calibrated span.

Stability: Within 0.25 percent of span per year.

Overpressure: 15 psig (103 kPa).

Temperature Limits: Minus 20 to 160 deg F (Minus 29 to 71 deg C).

Compensate Temperature Limits: 35 to 135 deg F (2 to 57 deg C).

Thermal Effects: 0.015 percent of full scale per degree F.

Warm-up Time: Within 5 seconds.

Response Time: [**5 ms**] [**250 ms**] [**One second**].

Shock and vibration shall not harm the transmitter.

Output Signals:

Retain only one of first two subparagraphs below to restrict signal options.

Analog Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Analog Voltage Signal:

Three wire, zero to [**5**] [**6**] V.

Minimum Load Resistance: 1000 ohms.

Operator Interface:

Zero and span adjustments within 10 percent of full span.

Potentiometer adjustments located on face of transmitter.

Construction:

Type 300 stainless-steel enclosure.

Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on front of instrument enclosure.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 2.

Mounting Bracket: Appropriate for installation.

Reverse wiring protected.

Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

* + - * 1. Air-Pressure Differential Transmitters for Hazardous Environments:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9803) Subject to compliance with requirements, provide products by the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123456944479).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Ashcroft's "Model iXLDP."

FM Approved for hazardous environments. Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, Groups A through H.

Performance:

Range: Approximately 2 times set point.

Accuracy: Within [**0.25**] [**0.5**] percent of the span at reference temperature of 70 degrees F.

Hysteresis: Within 0.02 percent of the span.

Repeatability: Within 0.05 percent of the calibrated span.

Stability: Within 0.25 percent of span per year.

Overpressure: 20 psig (138 kPa).

Temperature Limits: Minus 20 to 185 deg F (Minus 29 to 85 deg C).

Compensate Temperature Limits: Zero to 160 deg F (Minus 18 to 71 deg C).

Thermal Effects: 0.01 percent of full scale per degree F.

Warm-up Time: Within 5 seconds.

Response Time: [**8 ms**] [**250 ms**].

Shock and vibration shall not harm the transmitter.

Output Signals:

Retain only one of first two subparagraphs below to restrict signal options.

Analog Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Analog Voltage Signal:

Three wire, zero to [**5**] [**6**] V.

Minimum Load Resistance: 1000 ohms.

Operator Interface:

Zero and span adjustments within 10 percent of full span.

Potentiometer adjustments located on face of transmitter.

Construction:

Type 300 stainless-steel enclosure.

Swivel fittings for connection to tubing. Fittings on bottom of instrument enclosure.

Two 1/2-inch (16-mm) trade size conduit connections isolated from electronics.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4X.

Mounting Bracket: Appropriate for installation.

Reverse wiring protected.

Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

Retain one of two "Air-Pressure Differential Indicating Transmitter" paragraphs below.

* + - * 1. Air-Pressure Differential Indicating Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9804) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944480).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series DM-2000."

Performance:

Range: Approximately 2 times set point.

Accuracy Including Hysteresis and Repeatability: Within 1 percent of full scale at 77 deg F (25 deg C).

Stability: Within 1 percent of full scale per year.

Overpressure: 10 psig (69 kPa).

Temperature Limits: 20 to 120 deg F (Minus 7 to 49 deg C).

Thermal Effects: 0.055 percent of full scale per degree F.

Display: Four-digit digital display with minimum 0.4-inch- (10-mm-)high numeric characters.

Operator Interface:

Zero and span adjustments.

Selectable engineering units.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into a 1200-ohm load.

Construction:

Plastic casing with clear plastic cover.

Integral fittings for plastic tubing connections on side of instrument case for high- and low-pressure connections.

Terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 1.

Nominal 4-inch (100-mm) diameter face.

Mounting Bracket: Appropriate for installation.

* + - * 1. Air-Pressure Differential Indicating Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9805) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456950125).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series 616W."

Performance:

Range: Approximately 2 times set point.

Accuracy including hysteresis and repeatability: Within 0.25 percent of full scale.

Stability: Within 1 percent of full scale per year.

Overpressure: Varies with range. At least 1.5 times range.

Temperature Limits: Zero to 140 deg F (Minus 18 to 60 deg C).

Compensate Temperature Limits: 20 to 120 deg F (Minus 7 to 49 deg C).

Thermal Effects: 0.02 percent of full scale per degree F.

Display: Digital with minimum 0.4-inch- (10-mm-) high numeric characters.

Operator Interface: Zero and span adjustments.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into a 1200-ohm load.

Construction:

Plastic casing with removable clear plastic cover.

Integral barbed fittings for rubber or plastic tubing connections on bottom of instrument case for high- and low-pressure connections.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4X.

Mounting Bracket: Appropriate for installation.

* + - * 1. Air-Pressure Differential Indicating Transmitter with Field-Selectable Features:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9806) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944481).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series MS."

Field-Selectable Features:

Field configurable for pressure and velocity applications through user interface.

Retain first subparagraph below for field-selectable pressure ranges. Feature not available in all pressure ranges.

Field selectable from one of three pressure ranges both in SI (metric) and inch-pound (IP) units of measure.

Select range based on application. Range shall be approximately 2 times set point.

Performance:

Accuracy Including Hysteresis and Repeatability:

Within 2 percent for 0.10 in. wg (25 Pa), 1.0 in. wg (250 Pa) and all bi-directional ranges.

Within 1 percent for other ranges.

Stability: Within 1 percent of full scale per year.

Response Time: Adjustable 0.5- to 15-second time constant with 95 percent response within 1.5 to 45 seconds.

Overpressure: 1 psig (6.9 kPa) maximum operating; 10 psig (69 kPa) burst pressure.

Temperature Limits: Zero to 150 deg F (Minus 18 to 66 deg C).

Display: Four-digit digital display with minimum 0.4-inch- (10-mm-) high numeric characters.

Operator Interface:

Selectable pressure ranges, where indicated.

Zero and span adjustments.

Selectable air velocity mode with square root function.

Adjustable signal dampening

Retain one of first two subparagraphs below to restrict signal options.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into a 1200-ohm load.

Analog Output Voltage Signal:

Three wire, zero to 10 V.

Minimum Load Resistance: 1000 ohms.

Construction:

Plastic casing with removable clear plastic cover.

NPS 3/16 (DN 7) nominal ID plastic tubing connections on side of instrument case for high- and low-pressure connections.

NPS 1/2 (DN 15) NPS threaded connection for conduit.

Terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4X.

Nominal 4-inch- (100-mm-) diameter face.

Mounting Bracket: Appropriate for installation.

* + - * 1. Air-Pressure Differential Transmitter with 0.10 Percent Accuracy and Auto Zero Feature:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9807) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944482).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "Veltron II."

Description:

4- to 20-mA dc output signal.

NEMA 250, Type 1 enclosure.

Construct the assembly so that shock, vibration, and pressure surges of up to 1 psig (6.9 kPa) will neither harm nor affect the accuracy of the transmitter.

Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.

Performance:

Range: Approximately 2 times set point.

Calibrated Span: Field adjustable, minus 40 percent of the range.

Accuracy: Within 0.10 percent of natural span.

Repeatability: Within 0.15 percent of calibrated span.

Linearity: Within 0.2 percent of calibrated span.

Hysteresis and deadband (combined): Less than 0.2 percent of calibrated span.

Integral digital display for continuous indication of pressure differential.

* + - * 1. Air-Pressure Differential Transmitter with 0.25 Percent Accuracy and Auto Zero Feature:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9808) Subject to compliance with requirements, provide products by the following:

[Air Monitor Corporation](http://www.specagent.com/Lookup?uid=123456944483).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Air Monitor's "DPT 2500 Plus."

Description:

4- to 20-mA dc output signal.

NEMA 250, Type 1 enclosure.

Construct assembly so shock, vibration, and pressure surges of up to 1 psig (6.9 kPa) will neither harm nor affect the accuracy of the transmitter.

Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.

Performance:

Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.

Calibrated Span: Field adjustable, minus 40 percent of the range.

Accuracy: Within 0.25 percent of natural span.

Repeatability: Within 0.15 percent of calibrated span.

Linearity: Within 0.2 percent of calibrated span.

Hysteresis and deadband (combined): Less than 0.2 percent of calibrated span.

Integral digital display for continuous indication of pressure differential.

* + - * 1. Air-Pressure Differential Indicating Transmitter, Switch, and Controller:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9809) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944484).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series DH3 Digihelic."

Description:

Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.

Field configurable for pressure, velocity, and volumetric flow applications through user interface.

Select instrument range based on application. Range shall be approximately 2 times set point.

Performance:

Accuracy Including Hysteresis and Repeatability:

Within 1 percent for ranges less than 5 in. wg (1250 Pa).

Within 0.5 percent at 77 deg F (25 deg C) for other ranges.

Stability: Within 1 percent per year.

Response Time: 250 ms.

Overpressure: 5 psig (34 kPa) for instrument ranges less than 50 in wg (12.5 kPa) and 9 psig (62 kPa) for 100 in. wg (25 kPa) range.

Temperature Limits: 32 to 140 deg F (Zero to 60 deg C).

Thermal Effects: 0.020 percent per degree F.

Warm-up Period: One hour.

Controller Programming through Menu Keys to Access Five Menus:

Security level.

Pressure, velocity, or flow application.

Engineering units.

K-factor for use with flow application.

Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.

View high and low readings.

Digital dampening for smoothing erratic applications.

Scaling of analog output to fit range and field calibration.

Display:

Digital, four-digit display with backlight, with 0.4-inch- (10-mm-) high alphanumeric characters.

Four indicators; two for set point and two for alarm status.

Operator Interface:

Set-point adjustment through keypad on face of instrument.

Zero and span adjustments accessible through menu.

Programming through keypad.

Analog Output Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into a 900-ohm load.

Digital Output Signal:

Two SPDT relays.

Each rated for one amp at 30-V ac or dc.

Construction:

Die cast-aluminum casing and bezel.

Threaded, NPS 1/8 (DN 6) connections on side and back.

Vertical plane mounting.

NEMA 250, Type 1.

Nominal 4-inch- (100-mm-) diameter face.

Mounting Bracket: Appropriate for installation.

* + - 1. LIQUID-PRESSURE SWITCHES
         1. Liquid Gage Pressure Switch, Diaphragm Operated, Low Pressure:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9810) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Mercoid Controls: Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944485).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Mercoid's "Series AP."

Description:

Diaphragm operated to actuate an SPDT snap switch.

Electrical Connections: Screw terminal.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: External screw with visual set-point adjustment.

Process Connection: Threaded, NPS 1/4 (DN 10).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 15 A at 120-V ac.

Pressure Limits:

Range 1 to 30 psig (7 to 207 kPa): 60 psig (414 kPa).

Range 10 to 125 psig (69 to 862 kPa): 160 psig (1103 kPa).

Temperature Limits: Minus 30 to 150 deg F (Minus 35 to 66 deg C).

Operating Range: [**1 to 30 psig (7 to 207 kPa)**] [**10 to 250 psig (69 to 862 kPa)**].

Deadband: Fixed.

Pressure Chamber Material: [**Steel**] [**or**] [**Stainless steel**].

Diaphragm Material: [**Nylon**] [**or**] [**PTFE**].

* + - * 1. Liquid Gage Pressure Switch-Diaphragm Operated:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9811) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Mercoid Controls: Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944486).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on "Mercoid's "Series SA 1000."

Diaphragm operated to actuate a [**SPDT**] [**or**] [**DPDT**] snap switch.

Electrical Connections: Screw terminal.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Internal hex nut set-point adjustment with enclosed set-point indicator and scale.

Process Connection: Threaded, [**NPS 1/4 (DN 6)**] [**or**] [**NPS 1/2 (DN 15)**].

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1, 12.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4X[**with drain**].

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 15 A at 120-, 240-, and 480-V ac.

Pressure Limits: 1200 psig (8274 kPa).

Ambient Temperature Limits: Minus 30 to 180 deg F (Minus 35 to 82 deg C).

Process Temperature Limits: Minus 4 to 167 deg F (Minus 20 to 75 deg C).

Adjustable Operating Range: [**10 to 150 psig (69 to 1034 kPa)**] [**20 to 250 psig (138 to 1724 kPa)**] [**30 to 500 psig (207 to 3447 kPa)**].

Deadband: Adjustable.

Pressure Chamber Material: [**Aluminum**] [**or**] [**brass**] [**or**] [**stainless steel**].

Diaphragm Material: [**Buna-N**] [**or**] [**fluorocarbon**].

* + - * 1. Liquid Gage Pressure Switch-Bourdon Tube Operated:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9812) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944487).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series DA, DS."

Description:

Bourdon tube operated to actuate a [**SPDT**] [**DPDT**] snap switch.

Provide switches used in safety limiting applications with [**auto**] [**manual**] reset.

Wetted Materials: [**Brass**] [**or**] [**Type 403 stainless steel**] [**or**] [**Type 316 stainless steel**].

Electrical Connections: Screw terminal.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.

Process Connection: Threaded, NPS 1/4 (DN 10).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: [**5**] [**10**] A at 120-V ac.

Pressure Limits: Equal to maximum pressure in full-scale range, but not less than system design pressure rating.

Temperature Limits: 180 deg F (82 deg C).

Operating Range: Approximately 2 times set point, but not less than system design pressure rating.

Deadband: [**Adjustable**] [**Fixed**] [**Adjustable or fixed as required by application**].

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

* + - * 1. Liquid-Pressure Differential Switch with Set-Point Indicator:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9813) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944488).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series DP."

Description:

[**Brass**] [**or**] [**Type 316 stainless-steel**] double opposing bellows operate to actuate a SPDT snap switch.

Electrical Connections: Screw terminal.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.

High and Low Process Connections: Threaded, NPS 1/8 (DN 3).

Enclosure:

Dry Indoor Installations: NEMA 250, Type 1.

Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

Hazardous Environments: Explosion proof.

Operating Data:

Electrical Rating: 15 A at 120- to 240-V ac.

Pressure Limits: At least 5 times full-scale range, but not less than system design pressure rating.

Temperature Limits: Minus 10 to 180 deg F (Minus 23 to 82 deg C).

Operating Range: Approximately 2 times set point.

Deadband: [**Adjustable**] [**Fixed**] [**Adjustable or fixed as required by application**].

* + - * 1. Liquid-Pressure Differential Switch:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9814) Subject to compliance with requirements, provide products by the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123456944489).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Ashcroft's "LPA, S Series."

Description:

Type 316 stainless-steel double opposing bellows operate to actuate an SPDT snap switch.

Wetted materials: Type 316 stainless steel.

First option in "Seal" Subparagraph below has process temperature limitation of 150 deg F (66 deg C).

Seal: [**Buna-N**] [**or**] [**Viton**].

Electrical Connections: Screw terminal.

Enclosure Conduit Connection: Knock out or threaded connection.

User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.

High and Low Process Connections: Threaded, NPS 1/4 (DN 10).

Enclosure: NEMA 250, Type 4 or 4X.

Operating Data:

Electrical Rating: 10 A at 120- to 240-V ac.

Pressure Limits: Zero to 500 psig (Zero to 3447 kPa).

Ambient Temperature Limits: Minus 20 to 150 deg F (Minus 29 to 66 deg C).

"Buna-N" seal has process temperature limitation of 150 deg F (66 deg C). Revise upper temperature limit in "Process Temperature Limits" Subparagraph below if using Buna-N material.

Process Temperature Limits: 20 to 300 deg F (Minus 7 to 149 deg C).

Operating Range: 2 times set point, unless otherwise required by application.

Deadband: [**Adjustable**] [**Fixed**] [**Adjustable or fixed as required by application**].

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

* + - 1. LIQUID-PRESSURE TRANSMITTERS
         1. Liquid Gage Pressure Transmitter with Adjustable Span[**for Hazardous Environments**]:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9815) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Rosemount; Emerson Process Management](http://www.specagent.com/Lookup?uid=123456944490).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Rosemount's "Model 3051CG." Retain "Hazardous Classification" Subparagraph below for transmitters located in hazardous environments.

Hazardous Classification: FM Approved for hazardous environments.

Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, Groups A through H.

Explosion proof for Class I, Division 1, Groups B, C, and D.

Retain one of first two subparagraphs below.

Dust ignition proof for Class II, Division 1, Groups E, F, and G.

Dust ignition proof for Class III, Division 1.

Performance:

Range: Minus 300 to 300 psig (Minus 2068 to 2068 kPa).

Span: Field adjustable.

Minimum Span: 3 psig (21 kPa).

Reference Accuracy: Within 0.07 percent of span or better.

Stability: Within 0.125 percent of upper range limit for 5 years.

Overpressure Limits: 3626 psig (25 000 kPa).

Process Temperature Limits: Minus 40 to 250 deg F (Minus 40 to 121 deg C).

Ambient Temperature Limits: Minus 40 to 185 deg F (Minus 40 to 85 deg C).

Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.

Shock and vibration shall not harm the transmitter.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Digital signal based on HART protocol carried with current signal.

Dampening: Field selectable from zero to 30 seconds.

Operator Interface: Zero and span adjustments located behind cover.

Retain "Display" Subparagraph below for display.

Display: Digital, five-digit, two-line display with 0.4-inch- (10-mm-) high alphanumeric characters.

Construction:

Non-wetted parts of transmitter constructed of aluminum or stainless steel.

Enclosure with removable cover on each side.

Wetted parts of transmitter constructed of Type 316 stainless steel.

Threaded, NPS 1/2 (DN 15) process connection on bottom of instrument.

Drain/vent valve on process connection.

Two 1/2-inch (16-mm) trade size conduit connections on side of instrument enclosure.

Screw terminal block for wire connections.

NEMA 250, Type 4X.

Mounting Bracket: Appropriate for installation.

* + - * 1. Liquid-Pressure Differential Transmitter with Adjustable Span[**for Hazardous Environments**]:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9816) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Rosemount; Emerson Process Management](http://www.specagent.com/Lookup?uid=123456944491).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Rosemount's "Model 3051CD."

Retain "Hazardous Classification" Subparagraph below for transmitters located in hazardous environments.

Hazardous Classification: FM Approved for hazardous environments.

Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, Groups A through H.

Explosion proof for Class I, Division 1, Groups B, C, and D.

Retain one of first two subparagraphs below.

Dust ignition proof for Class II, Division 1, Groups E, F, and G.

Dust ignition proof for Class III, Division 1.

Performance:

Range: Minus 300 to 300 psig (Minus 2068 to 2068 kPa).

Span: Field adjustable.

Minimum Span: 3 psig (21 kPa).

Reference Accuracy: Within 0.07 percent of span or better.

Stability: Within 0.125 percent of upper range limit for 5 years.

Overpressure Limits: 3626 psig (25 000 kPa).

Process Temperature Limits: Minus 40 to 250 deg F (Minus 40 to 121 deg C).

Ambient Temperature Limits: Minus 40 to 185 deg F (Minus 40 to 85 deg C).

Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.

Shock and vibration shall not harm the transmitter.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Digital signal based on HART protocol carried with current signal.

Dampening: Field selectable from zero to 30 seconds.

Operator Interface: Zero and span adjustments located behind cover.

Retain "Display" Subparagraph below for display.

Display: Digital, five-digit, two-line display with 0.4-inch- (10-mm-) high alphanumeric characters.

Construction:

Non-wetted parts of transmitter constructed of aluminum or stainless steel.

Enclosure with removable cover on each side.

Wetted parts of transmitter constructed of Type 316 stainless steel.

Threaded, NPS 1/2 (DN 15) process connection on bottom of instrument.

Drain/vent valve on process connection.

Two 1/2-inch (16-mm) trade size conduit connections on side of instrument enclosure.

Screw terminal block for wire connections.

NEMA 250, Type 4X.

Mounting Bracket: Appropriate for installation.

Retain one of two "Liquid-Pressure Differential Transmitter" paragraphs below.

* + - * 1. Liquid-Pressure Differential Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9817) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944492).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series 645."

Performance:

Range: Approximately 2 times set point.

Span: Adjustable plus or minus one milliamp, noninteractive.

Accuracy: Within 0.25 percent of full scale.

Pressure: Maximum operating pressure 2.5 times range.

Temperature Limits: Zero to 175 deg F (Minus 18 to 79 deg C).

Compensate Temperature Limits: 30 to 150 deg F (Minus 1 to 66 deg C).

Thermal Effects: 0.02 percent of full scale per degree F.

Response Time: 30 to 50 ms.

Shock and vibration shall not harm the transmitter.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Operator Interface:

Zero and span adjustments located behind cover.

Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

Construction:

Aluminum and stainless-steel enclosure with removable cover.

Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.

Threaded, NPS 1/4 (DN 10) process connections on side of instrument enclosure.

Knock out for 1/2-inch (16-mm) nominal conduit connection on side of instrument enclosure.

Screw terminal block for wire connections.

NEMA 250, Type 4X.

Mounting Bracket: Appropriate for installation.

Retain subparagraph below for optional three-valve manifold.

Three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Manifold shall have threaded, NPS 1/4 (DN 10) process connections.

* + - * 1. Liquid-Pressure Differential Transmitter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9818) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[Setra System](http://www.specagent.com/Lookup?uid=123456944493).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Setra's "Model 230."

Performance:

Range: Approximately 2 times the set point.

Span: Adjustable plus or minus one milliamp, noninteractive.

Accuracy: Within 0.25 percent of full scale.

Hysteresis: Within 0.1 percent of full scale.

Repeatability: Within 0.05 percent of full scale.

Maximum Working Pressure: 250 psig (1724 kPa).

Temperature Limits: Zero to 175 deg F (Minus 18 to 79 deg C).

Compensate Temperature Limits: 30 to 150 deg F (Minus 1 to 66 deg C).

Thermal Effects: 0.02 percent of full scale per degree F.

Response Time: 30 to 50 ms.

Shock and vibration shall not harm the transmitter.

Retain one of first two subparagraphs below to restrict signal options.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Analog Output Voltage Signal:

Three wire, zero to [**5**] [**10**] V.

Minimum Load Resistance: 1000 ohms.

Operator Interface:

Zero and span adjustments located behind cover.

Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

Construction:

Aluminum and stainless-steel enclosure with removable cover.

Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.

Threaded, NPS 1/4 (DN 10) process connections on side of instrument enclosure.

Knock out for 1/2-inch (15-mm) nominal conduit connection on side of instrument enclosure.

Screw terminal block for wire connections.

NEMA 250, Type 4.

Mounting Bracket: Appropriate for installation.

Retain subparagraph below for optional three-valve manifold.

Provide transmitter with three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Provide manifold with NPS 1/4 (DN 10) NPT process connections.

Retain one of two "Liquid-Pressure Differential Transmitter with Field-Selectable Range" paragraphs below.

* + - * 1. Liquid-Pressure Differential Transmitter with Field-Selectable Range:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9819) Subject to compliance with requirements, provide products by the following:

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123456944494).

Johnson Controls

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on Dwyer's "Series WWDP."

Performance:

Field-Selectable Range:

Retain one of first three subparagraphs below.

5, 10, 25, 50 psig (34, 69, 172, 345 kPa).

10, 20, 50, 100 psig (69, 138, 345, 689 kPa).

25, 50, 125, 250 psig (172, 345, 862, 1724 kPa).

Field-selectable unidirectional or bidirectional range.

Accuracy: Within 1 percent of the full-scale range, except lowest selectable range within 2 percent.

Stability: Within 0.5 percent of span per year.

Pressure: Maximum operating pressure equal to highest pressure in range.

Overpressure: Proof pressure 2.2 times full scale; burst pressure 40 times full scale.

Temperature Limits: Minus 44 to 185 deg F (Minus 42 to 85 deg C).

Compensate Temperature Limits: 32 to 130 deg F (Zero to 54 deg C).

Thermal Effects: 2 percent of full scale per 100 deg F (56 deg C).

Response Time: Field selectable from 1 to 5 seconds.

Shock and vibration shall not harm the transmitter.

Configurable Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Configurable Analog Output Voltage Signals:

Three wire, zero to 5 V, zero to 10 V, and 1 to 5 V.

Minimum Load Resistance: 1000 ohms.

Retain "Display" Subparagraph below for optional display.

Display: Four-digit LCD with minimum 0.4-inch- (10-mm-)high numeric characters.

Operator Interface:

Digital zero button located behind cover.

Range selector located behind cover.

Construction:

Cast-aluminum enclosure with removable cover.

Wetted parts of transmitter constructed of 17-4 PH stainless steel.

Threaded, NPS 1/8 (DN 6) process connections on bottom of instrument enclosure.

1/2-inch (16-mm) trade size connection for conduit on bottom of instrument enclosure.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4.

Mounting Bracket: Appropriate for installation.

* + - * 1. Liquid-Pressure Differential Transmitter with Field-Selectable Ranges:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9820) Subject to compliance with requirements, provide products by the following:

Johnson Controls

[MAMAC Systems, Inc](http://www.specagent.com/Lookup?uid=123456944495).

Siemens Industry, Inc., Building Technologies Division

Approved equivalent.

Requirements in remaining subparagraphs below are based on "MAMAC's PR-283."

Performance:

Field-Selectable Ranges:

Retain one of first three subparagraphs below.

5, 10, 20 psig (34, 69, 138 kPa).

25, 50, 100 psig (172, 345, 689 kPa).

75, 150, 300 psig (517, 1034, 2068 kPa).

Accuracy: Within 1 percent of the full-scale range.

Static Pressure: 2 times full-scale range.

Overpressure: Proof pressure 3 times full-scale range, burst pressure 5 times full scale.

Compensate Temperature Limits: Zero to 180 deg F (Minus 18 to 82 deg C).

Thermal Effects: 0.025 percent of full scale per degree F.

Shock and vibration shall not harm the transmitter.

Retain one of first two subparagraphs below to restrict output signal.

Analog Output Current Signal:

Two-wire, 4- to 20-mA dc current source.

Signal capable of operating into 1000-ohm load.

Analog Output Voltage Signals:

Three wire, field selectable from zero to 5 V or zero to 10 V.

Minimum Load Resistance: 1000 ohms.

Operator Interface:

Zero button located behind cover.

Range selector located behind cover.

Construction:

0.0478-inch- (1.214-mm-) thick, corrosion-resistant steel enclosure with baked-enamel finish.

Removable front cover.

Wetted parts of transmitter constructed of 17-4 PH stainless steel.

Threaded, NPS 1/8 (DN 6) process connections on bottom of instrument enclosure.

1/2 inch (16 mm) trade size conduit on side of instrument enclosure.

Screw terminal block for wire connections.

Vertical plane mounting.

NEMA 250, Type 4.

Mounting Bracket: Appropriate for installation.

Retain first subparagraph below for optional three-valve manifold.

Provide transmitter with three-valve manifold.

Construct manifold of Type 316 stainless steel.

Manifold with threaded, NPS 1/4 (DN 10) process connections.

* + - 1. SOURCE QUALITY CONTROL

Retain "Factory Tests" Paragraph below for factory-assembled instruments. Factory tests are an added cost option and may not be available from some manufacturers. Verify requirement with Owner.

* + - * 1. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.
        2. Prepare test and inspection reports.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
          2. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
          3. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
          4. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
          5. Proceed with installation only after unsatisfactory conditions have been corrected.

Retain "Pressure Instrument Applications" Article below unless all requirements for instruments for different applications are indicated on Drawings. Where Drawings indicate only some requirements, revise this article accordingly.

Options indicated in "Pressure Instrument Applications" Article are provided where multiple product options are specified. Where only a single product is specified for an instrument type, the "Pressure Instrument Applications" Article can be deleted.

* + - 1. PRESSURE INSTRUMENT APPLICATIONS

If selection of instruments is delegated to Contractor, delete this article.

Indicate static pressure instruments on Drawings.

* + - * 1. Duct-Mounted Static Pressure Sensors:

Copy and revise subparagraph below to suit each unique application requiring a different type of duct-mounted static pressure sensor.

<**Insert system**> System, <**Insert unique application**>: [**Duct insertion static pressure sensor**] [**Duct traverse static pressure sensor**].

* + - * 1. Space Static Pressure Sensors:

<**Insert system**> System, <**Insert unique application**>: [**Space static pressure sensor for wall mounting**] [**Space static pressure sensor for recessed ceiling mounting**] [**Space static pressure sensor for exposed or suspended mounting**].

* + - * 1. Air-Pressure Differential Switches:

Copy and revise subparagraph below to suit each unique application requiring a different type of air-pressure differential switch.

<**Insert system**> System, <**Insert unique application**>: [**Air-pressure differential switch**] [**Air-pressure differential switch with set-point indicator**] [**Air-pressure differential switch with dual scale adjustable set point**] [**Air-pressure-differential indicating**].

* + - * 1. Air-Pressure Differential Transmitters:

Copy and revise subparagraphs below to suit each unique application requiring a different type of air-pressure differential transmitter. Use most accurate transmitter with auto zero feature for critical applications.

Duct, <**Insert system**> System, <**Insert unique application**>: [**Air-pressure differential transmitter**] [**Air-pressure differential transmitter for hazardous environments**] [**Air-pressure differential indicating transmitter**] [**Air-pressure differential transmitter with 0.10 percent accuracy and auto zero feature**] [**Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature**] [**Air-pressure differential indicating transmitter, switch, and controller**].

Space, <**Insert system**> System, <**Insert unique application**>: [**Air-pressure differential transmitter**] [**Air-pressure differential transmitter for hazardous environments**] [**Air-pressure differential indicating transmitter**] [**Air-pressure differential transmitter with 0.10 percent accuracy and auto zero feature**] [**Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature**] [**Air-pressure differential indicating transmitter, switch, and controller**].

* + - * 1. Liquid Gage Pressure Switches:

Copy and revise subparagraph below to suit each system and unique application requiring a different type of gage pressure switch. Where "<Insert system>" is indicated, insert system type: "chilled-," "condenser-," "heat recovery-," "hot-water", or "steam". Where "<Insert unique application>" is indicated, insert unique requirement, such as equipment class, or if common to all, insert "General."

<**Insert system**> System, <**Insert unique application**>: [**Liquid gage pressure switch, diaphragm operated, low pressure**] [**Liquid gage pressure switch, diaphragm operated**] [**Liquid gage pressure switch, bourdon-tube operated**].

* + - * 1. Liquid-Pressure Differential Switches:

Copy and revise subparagraph below to suit each system and unique application requiring a different type of pressure differential switch. Where "<Insert system>" is indicated, insert system type: "chilled-," "condenser-," "heat recovery-," "hot-water," or "steam." Where "<Insert unique application>" is indicated, insert unique requirement, such as equipment class, or if common to all, insert "General."

<**Insert system**> System, <**Insert unique application**>: [**Liquid-pressure differential switch with set-point indicator**] [**Liquid-pressure differential switch**].

* + - * 1. Liquid-Pressure Differential Transmitters:

Copy and revise subparagraph below to suit each system and unique application requiring a different type of liquid-pressure differential transmitter. Where "<Insert system>" is indicated, insert system type: "chilled-," "condenser-," "heat recovery-," "hot-water," or "steam." Where "<Insert unique application>" is indicated, insert unique requirement, such as equipment class, or if common to all, insert "General."

<**Insert system**> System, <**Insert unique application**>: [**Liquid-pressure differential transmitter with adjustable span**] [**Liquid-pressure differential transmitter**] [**Liquid-pressure differential transmitter with field-selectable range**].

* + - 1. INSTALLATION, GENERAL
         1. Install products level, plumb, parallel, and perpendicular with building construction.
         2. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a <**Insert value**> force.
         3. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
         4. Fastening Hardware:

Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.

Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.

Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

* + - * 1. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Director’s Representative's access, confirm unrestricted ladder placement is possible under occupied condition.
        2. Corrosive Environments:

Use products that are suitable for environment to which they are subjected.

If possible, avoid or limit use of materials in corrosive environments.

When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

* + - 1. ELECTRICAL POWER
         1. Provide electrical power to products requiring electrical connections.
         2. Provide circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
         3. Provide power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
         4. Provide raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
      2. PRESSURE INSTRUMENT INSTALLATION
         1. Mounting Location:

Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.

Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of [**2**] [**3**] <**Insert number**> percent.

Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of [**2**] [**3**] <**Insert number**> percent.

* + - * 1. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
        2. Duct Pressure Sensors:

Indicate locations of sensors on Drawings.

Install sensors using manufacturer's recommended upstream and downstream distances.

Unless indicated on Drawings, locate sensors approximately [**50**] [**67**] [**75**] percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.

Install mounting hardware and gaskets to make sensor installation airtight.

Route tubing from the sensor to transmitter.

Use compression fittings at terminations.

Install sensor in accordance with manufacturer's instructions.

Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

* + - * 1. Outdoor Pressure Sensors:

Indicate locations of sensors on Drawings.

Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.

Locate wall-mounted sensor in an inconspicuous location.

Submit sensor location for approval before installation.

Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.

Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.

Install sensor signal pipe with dirt leg and drain valve below roof penetration.

Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.

Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

* + - * 1. Air-Pressure Differential Switches:

Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.

A single sensor may be used to share a common signal to multiple pressure instruments.

Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.

Route NPS 3/8 (DN 12) tubing from sensor to switch connection.

Do not mount switches on rotating equipment.

Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.

Install switches in an easily accessible location serviceable from floor.

Install switches adjacent to system control panel if within [**50 feet (15 m)**] <**Insert distance**>; otherwise, locate switch in vicinity of system connection.

* + - * 1. Liquid-Pressure Differential Switches:

Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.

Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.

Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.

System process tubing connection shall be full size of switch connection, but not less than [**NPS 1/2 (DN 15)**] [**NPS 3/4 (DN 20)**] [**NPS 1 (DN 25)**]. Install[**stainless-steel**] bushing if required to mate switch to system connection.

Connect process tubing from point of system connection and extend to switch.

Install isolation valves in process tubing as close to system connection as practical.

Install dirt leg and drain valve at each switch connection.

Do not mount switches on rotating equipment.

Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.

Install switches in an easily accessible location serviceable from floor.

* + - * 1. Liquid-Pressure Transmitters:

Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.

Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.

Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.

System process tubing connection shall be full size of switch connection, but not less than [**NPS 1/2 (DN 15)**] [**NPS 3/4 (DN 20)**] [**NPS 1 (DN 25)**]. Install[**stainless-steel**] bushing if required to mate switch to system connection.

Connect process tubing from point of system connection and extend to transmitter.

Install isolation valves in process tubing as close to system connection as practical.

Install dirt leg and drain valve at each transmitter connection.

Do not mount transmitters on equipment.

Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

* + - 1. IDENTIFICATION
         1. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
         2. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].
      2. CHECKOUT PROCEDURES
         1. Check out installed products before continuity tests, leak tests, and calibration.
         2. Check instruments for proper location and accessibility.
         3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.
      3. ADJUSTMENT, CALIBRATION, AND TESTING
         1. Description:

Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

For each analog instrument, perform a three-point calibration test for both linearity and accuracy.

Equipment and procedures used for calibration shall comply with instrument manufacturer's recommendations.

Provide diagnostic and test equipment for calibration and adjustment.

Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.

Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

* + - * 1. Analog Signals:

Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

Check analog current signals using a precision current meter at zero, 50, and 100 percent.

* + - * 1. Digital Signals:

Check digital signals using a jumper wire.

Check digital signals using an ohmmeter to test for contact.

* + - * 1. Sensors: Check sensors at zero, 50, and 100 percent of project design values.
        2. Switches: Calibrate switches to make or break contact at set points indicated.
        3. Transmitters:

Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

* + - 1. ADJUSTING
         1. Occupancy Adjustments: When requested within [**12**] <**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.
      2. MAINTENANCE SERVICE

Verify, with Owner, that maintenance service is required for Project.

* + - * 1. Maintenance Service: In addition to the contractors 1-year project warranty requirements, beginning at Substantial Completion, maintenance service shall include [**three**] [**six**] [**nine**] [**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**] [**manufacturer's authorized service representative**]. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
      1. DEMONSTRATION
         1. [**Engage a factory-authorized service company field advisor to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
         2. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Director’s Representative in operating, maintaining, and troubleshooting.
         3. Record videos on DVD disks.
         4. Director’s Representative shall have right to make additional copies of video for internal use without paying royalties.
         5. Director’s Representative shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.23