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SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes control valves and actuators for DDC systems.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
 - 2. Section 230933 "Electric and Electronic Control System for HVAC" for electric/electronic control valves and actuators in electric and electronic control systems.
 - 3. Section 230943 "Pneumatic Control System for HVAC" for pneumatic control valves and actuators in pneumatic control systems.
 - 4. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.
- C. Cv: Design valve coefficient.
- D. DDC: Direct-digital control.

CONTROL VALVES

- E. NBR: Nitrile butadiene rubber.
- F. PTFE: Polytetrafluoroethylene
- G. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation, operation, and maintenance instructions, including factors affecting performance.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and[**mounting**] details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include diagrams for pneumatic signal and main air tubing.
- C. Delegated-Design Submittal:
 - 1. Schedule and design calculations for control valves and actuators, including the following:
 - a. Flow at project design and minimum flow conditions.
 - b. Pressure differential drop across valve at project design flow condition.
 - c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.

1.4 INFORMATIONAL SUBMITTALS

CONTROL VALVES

- A. 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:
1. Control valve installation location shown in relationship to room, duct, pipe, and equipment.
 2. Size and location of wall access panels for control valves installed behind walls.
 3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Delegated Design: Engage a qualified professional[**engineer**], as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.
- D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- E. Backup Power Source: Systems and equipment served by a backup power source shall have associated control valve actuators served from a backup power source.
- F. Environmental Conditions:
1. Provide electric control valve actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control valve actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.
 - a. Hazardous Locations: Explosion-proof rating for condition.
- G. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- H. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- I. Selection Criteria:
1. Control valves shall be suitable for operation at following conditions:

CONTROL VALVES

- a. Chilled Water: <Insert pressure and coincident temperature requirements>.
 - b. Condenser Water: <Insert pressure and coincident temperature requirements>.
 - c. Heat Recovery: <Insert pressure and coincident temperature requirements>.
 - d. Heating Hot Water: <Insert pressure and coincident temperature requirements>.
 - e. Steam: <Insert pressure and coincident temperature requirements>.
 - f. <Insert system and requirements>.
2. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
 3. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
 4. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
 5. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
 6. Modulating butterfly valves shall have [linear] [or] [equal percentage] flow-throttling characteristics.
 7. Fail positions unless otherwise indicated:
 - a. Chilled Water: [Close] [Last position] [Open].
 - b. Condenser Water: [Close] [Last position] [Open].
 - c. Heat Recovery: [Close] [Last position] [Open].
 - d. Heating Hot Water: [Close] [Last position] [Open].
 - e. Steam: [Close] [Last position] [Open].
 - f. <Insert system and fail position>.
 8. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
 9. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
 10. Selection shall consider viscosity, flashing, and cavitation corrections.
 11. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
 12. Minimum Cv shall be calculated at [10] <Insert number> percent of design flow, with a coincident pressure differential equal to the system design pump head.
 13. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of [5 psig ((34 kPa))] [7 psig ((48 kPa))] <Insert value> at design flow unless otherwise indicated.
 14. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:
 - a. [50] <Insert number> percent of the valve inlet pressure.
 - b. [50] <Insert number> percent of the absolute steam pressure at the valve inlet.
 15. Two-position control valves shall be line size unless otherwise indicated.
 16. In water systems, use ball- or globe-style control valves for two-position control for valves NPS 2 ((DN 50)) and smaller and butterfly style for valves larger than NPS 2 (DN 50).

17. In steam systems, use ball- or globe-style control valves regardless of size.
18. Pneumatic, two-position control valves shall provide a smooth opening and closing characteristic slow enough to avoid water hammer. Valves with pneumatic actuators shall have an adjustable opening time (valve full closed to full open) and an adjustable closing time (valve full open to full closed) ranging from zero to 10 seconds. Opening and closing times shall be independently adjustable.
19. Control valve, pneumatic-control signal shall not exceed **200 feet (60 m)**. For longer distances, provide an electric/electronic control signal to the valve and an electric solenoid valve or electro-pneumatic transducer at the valve to convert the control signal to pneumatic.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Belimo Americas (USA), Inc., Belimo Automation AG; B2 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Pressure Rating for **NPS 1 (DN 25)** and Smaller: Nominal 600 WOG.
3. Pressure Rating for **NPS 1-1/2 (DN 38)** through **NPS 2 (DN 50)**: Nominal 400 WOG.
4. Close-off Pressure: **200 psig (1379 kPa)**.
5. Process Temperature Range: **Zero to 212 deg F (Minus 18 to plus 100 deg C)**.
6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
7. End Connections: Threaded (NPT) ends.
8. Ball: **[Chrome-plated brass or bronze] [or] [300 series stainless steel]**.
9. Stem and Stem Extension:
 - a. Material to match ball.
 - b. Blowout-proof design.
 - c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
10. Ball Seats: Reinforced PTFE.
11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
12. Flow Characteristic: Equal percentage.

B. Ball Valves with Two Ports and Characterized Disk:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:

- a. Belimo Americas (USA), Inc., Belimo Automation AG; B3 series.
 - b. <Insert manufacturer's name; product name or designation>.
2. Pressure Rating for **NPS 1 (DN 25)** and Smaller: Nominal 600 WOG.
 3. Pressure Rating for **NPS 1-1/2 (DN 38)** through **NPS 2 (DN 50)**: Nominal 400 WOG.
 4. Close-off Pressure: **200 psig (1379 kPa)**.
 5. Process Temperature Range: **Zero to 212 deg F (Minus 18 to plus 100 deg C)**.
 6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
 7. End Connections: Threaded (NPT) ends.
 8. Ball: [**Chrome-plated brass or bronze**] [or] [**300 series stainless steel**].
 9. Stem and Stem Extension:
 - a. Material to match ball.
 - b. Blowout-proof design.
 - c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
 10. Ball Seats: Reinforced PTFE.
 11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
 12. Flow Characteristics for A-Port: Equal percentage.
 13. Flow Characteristics for B-Port: Modified for constant common port flow.

C. Ball Valves with Single Port and Segmented Ball:

1. Products: Subject to compliance with requirements, [**provide the following**] [**provide one of the following**] [**available products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. Valve Solutions, Inc.; V series.
 - b. <Insert manufacturer's name; product name or designation>.
2. Performance:
 - a. Process Temperature Rating: **Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**.
 - b. ASME B16.34, [**Class 150**] [or] [**Class 300**].
 - c. Leakage: FCI 70-2, Class IV.
 - d. Rangeability: 300 to 1.
 - e. Rotation: Zero to 90 degrees.
 - f. Equal percentage flow characteristic.
3. ASME B16.10 face-to-face dimensions.
4. Valves **NPS 2 (DN 50)** and Smaller: Threaded (NPT) ends.
5. Valves **NPS 2-1/2 (DN 65)** through **NPS 6 (DN 150)**: Flanged ends suitable for mating to ASME B16.5 flanges.
6. Body: [**Carbon**] [or] [**stainless**] steel.
7. Ball and Shaft: Stainless steel.

8. Shaft and Segmented Ball: Pinned and welded.
9. Ball Seat: Graphite.
10. Packing: PTFE V-rings and graphite packing follower.
11. Replaceable seat, ball, and shaft packing.
12. Label each valve with following:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Flow directional arrow.

D. Ball Valves with Segmented Ball, Three-Way Pattern:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Valve Solutions, Inc.; V series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Arrangement: Two single-port valves mated to a fabricated tee with interconnecting mechanical linkage.
3. Performance:
 - a. Process Temperature Rating: **Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**.
 - b. ASME B16.34, **[Class 150] [or] [Class 300]**.
 - c. Leakage: FCI 70-2, Class IV.
 - d. Rangeability: 300 to 1.
 - e. Rotation: Zero to 90 degrees.
 - f. Equal percentage flow characteristic.
4. Face-to-Face Dimensions: ASME B16.10.
5. Valves **NPS 3 ((DN 80))**through **NPS 6 (DN 150)**: Flanged ends suitable for mating to ASME B16.5 flanges.
6. Body: **[Carbon] [or] [stainless]** steel.
7. Ball and Shaft: Stainless steel.
8. Shaft and Segmented Ball: Pinned and welded.
9. Ball Seat: Graphite.
10. Packing: PTFE V-rings and graphite packing follower.
11. Replaceable seat, ball, and shaft packing.
12. Label each valve with following:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Flow directional arrow.

E. Ball Valves with Full Ball and Characterized V-Notch:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**

- a. Flow-Tek, a subsidiary of Bray International, Inc.; Triad and F series.
 - b. <Insert manufacturer's name; product name or designation>.
2. Performance:
- a. Process Temperature Rating: Minus 20 to plus 500 deg F (Minus 29 to plus 232 deg C).
 - b. ASME B16.34, Class 600 for NPS 2 (DN 50) and smaller; [Class 150] [or] [Class 300] for larger than NPS 2 (DN 50).
 - c. Leakage: FCI 70-2, Class VI, bi-directional.
 - d. Rangeability: Varies from 200 to 1 up to 800 to 1 based on notch pattern of ball.
 - e. Rotation: Zero to 90 degrees.
 - f. Equal percentage flow characteristic.
 - g. Full port.
3. Face-to-Face Dimension: ASME B16.10 long pattern.
4. Valves NPS 2 (DN 50) and Smaller: ASME B1.20.1 threaded (NPT) ends and three-piece body.
5. Valves NPS 2-1/2 (DN 65) through NPS 12 (DN 300): Flanged ends suitable for mating to ASME B16.5 flanges and two-piece body.
6. Hole in the stem slot of each ball equalizes pressure between the body cavity and the line media flow.
7. Replaceable seat, ball, and shaft packing.
8. Body: [Carbon] [or] [stainless] steel.
9. Ball and Shaft: Stainless steel.
10. Ball Seat: RPTFE.
11. Stem Seals for Valves NPS 2 (DN 50) and Smaller: Live-loaded, self-adjusting, primary and secondary sealing using belleville washers.
- a. Primary Seal: Combination of thrust washer and thrust washer protector.
 - b. Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.
12. Stem Seals for Valves Larger than NPS 2 (DN 50): Independent packing gland, adjusted without removing mounting hardware or operator, and contoured to uniformly distribute load across packing.
- a. Primary Seal: Combination of thrust washer and thrust washer protector.
 - b. Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.
13. Label each valve with following:
- a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Flow directional arrow.
- F. Industrial-Grade Ball Valves:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Fisher Valves & Instruments, Emerson Electric Co.; V150 or V300 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Performance:
- a. Process Temperature Rating: **Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**.
 - b. ASME B16.34, **[Class 150] [or] [Class 300]**.
 - c. Leakage: FCI 70-2, Class VI.
 - d. Rangeability: 300 to 1.
 - e. Rotation: Zero to 90 degrees.
 - f. Modified equal percentage flow characteristic.
3. Face-to-Face Dimensions: Comply with ASME B16.10 short pattern.
4. Body: Cast steel ASTM A 216/A 216M WCB.
5. Flanged Body: Suitable for mating to ASME B16.5 flanges.
6. Shaft: 316 stainless-steel ball, 17-4 PH stainless steel.
7. Ball Seat: Reinforced PTFE.
8. PTFE V-ring packing, 316 stainless-steel packing follower.
9. Replaceable seat, ball, and shaft packings.
10. Replaceable 316 stainless-steel shaft bushings with PTFE linings.
11. Corrosion-resistant nameplate indicating the following:
- a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Body and trim materials.
 - d. Trim type.
 - e. Body and flange rating.
 - f. Arrow indicating direction of flow.
- G. Pressure-Independent Ball Valves **NPS 2 (DN 50)** and Smaller:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hydronic Components, Inc. (HCi); 81, 83, and 85 series or comparable product by one of the following:
 - a. Jomar Hydronics.
 - b. **<Insert manufacturer's name>**.
 2. Performance:
 - a. Pressure Rating: **360 psig (2482 kPa)** for **NPS 1/2 to 1-1/4 (DN 15 to 32)** and **230 psig (1585 kPa)** for **NPS 1-1/2 to NPS 2 (DN 38 to DN 50)**.
 - b. Close-off pressure of **200 psig (1379 kPa)**.
 - c. Process Temperature Range: Between **14 to 248 deg F (minus 10 to plus 120 deg C)**.
 - d. Rangeability: 100 to 1.
 3. Integral Pressure Regulator: to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of **5 to 58 psig ((34 to 400 kPa))**.

4. Body: Forged brass, or cast iron, and with threaded ends.
5. Ball: Chrome-plated brass.
6. Stem and Stem Extension: Brass, blowout-proof design.
7. Ball Seats: PTFE.
8. Stem Seal: PTFE packing ring stem seal with EPDM.
9. Flow Characteristic: Equal percentage and/or linear.

2.3 BUTTERFLY-STYLE CONTROL VALVES

A. Commercial-Grade, Two-Way Butterfly Valves:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Keystone, a brand of Tyco Flow Control; Figure 222 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Performance:
 - a. Bi-directional bubble tight shutoff at **250 psig (1724 kPa)**.
 - b. Comply with MSS SP-67 or MSS SP-68.
 - c. Rotation: Zero to 90 degrees.
 - d. Linear or modified equal percentage flow characteristic.
3. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
4. Disc: 316 stainless steel.
5. Shaft: 316 or 17-4 PH stainless steel.
6. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Body and trim materials.
 - d. Flow arrow.

B. Commercial-Grade, Three-Way Butterfly Valves:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Keystone, a brand of Tyco Flow Control; Figure 222 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.

3. Performance:
 - a. Bi-directional bubble tight shutoff at **250 psig (1724 kPa)**.
 - b. Comply with MSS SP-67 or MSS SP-68.
 - c. Rotation: Zero to 90 degrees.
 - d. Linear or modified equal percentage flow characteristic.
4. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
5. Disc: 316 stainless steel.
6. Shaft: 316 or 17-4 PH stainless steel.
7. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
8. Shaft Bushings: Reinforced PTFE or stainless steel.
9. Replaceable seat, disc, and shaft bushings.
10. Corrosion-resistant nameplate indicating:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body size.
 - c. Body and trim materials.
 - d. Flow arrow.

C. Industrial-Grade Butterfly Valves:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Fisher Valves & Instruments, Emerson Electric Co.; 8532 and 8580 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Performance:
 - a. Process Temperature Rating: **Minus 200 to plus 849 deg F (Minus 129 to plus 454 deg C)**.
 - b. ASME B16.34, **[Class 150] [or] [Class 300]** for larger sizes.
 - c. Complies with MSS SP-68.
 - d. Leakage: FCI 70-2, Class VI, bi-directional.
 - e. Rangeability: 100 to 1.
 - f. Rotation: Zero to 90 degrees.
 - g. Linear or modified equal percentage flow characteristic.
3. Body: Cast steel ASTM A 216/A 216M WCB, fully lugged, suitable for mating to ASME B16.5 flanges.
4. Disc: ASTM A 351/A 351M, CF3M or CF8M stainless steel.
5. Shaft: 17-4 PH stainless steel.
6. Seat: Reinforced PTFE with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:
 - a. Manufacturer's name, model number, and serial number.

- b. Body size.
- c. Body and trim materials.
- d. Body rating.
- e. Arrow indicating direction of flow.

2.4 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:

1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.
2. Construct the valves to be serviceable from the top.
3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves **NPS 1 (DN 25)** and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body and trim size.
 - c. Arrow indicating direction of flow.

B. Two-Way Globe Valves **NPS 2 (DN 50)** and Smaller:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Johnson Controls, Controls Group; VG7000 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Globe Style: Single port.
3. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
4. End Connections: Threaded.
5. Bonnet: Screwed.
6. Packing: PTFE V-ring.
7. Plug: Top guided.
8. Plug, Seat, and Stem: **[Brass] [or] [stainless steel]**.
9. Process Temperature Range: **35 to 248 deg F (2 to 120 deg C)**.
10. Ambient Operating Temperature: **35 to 150 deg F (2 to 65 deg C)**.
11. Leakage: FCI 70-2, Class IV.
12. Rangeability: 25 to 1.
13. Equal percentage flow characteristic.

C. Three-Way Globe Valves **NPS 2 (DN 50)** and Smaller:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**

- a. Johnson Controls, Controls Group; VG7000 series.
 - b. <Insert manufacturer's name; product name or designation>.
2. Globe Style: Mix flow pattern.
 3. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
 4. End Connections: Threaded.
 5. Bonnet: Screwed.
 6. Packing: PTFE V-ring.
 7. Plug: Top guided.
 8. Plug, Seat, and Stem: **[Brass] [or] [stainless steel]**.
 9. Process Temperature Range: **35 to 248 deg F (2 to 120 deg C)**.
 10. Ambient Operating Temperature: **35 to 150 deg F (2 to 65 deg C)**.
 11. Leakage: FCI 70-2, Class IV.
 12. Rangeability: 25 to 1.
 13. Linear flow characteristic.
- D. Two-Way Globe Valves **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**:
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Johnson Controls, Controls Group; VG2000 series.
 - b. <Insert manufacturer's name; product name or designation>.
 2. Globe Style: Single port.
 3. Body: Cast iron complying with ASME B61.1, Class 125.
 4. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
 5. Bonnet: Bolted.
 6. Packing: PTFE cone-ring.
 7. Plug: Top or bottom guided.
 8. Plug, Seat, and Stem: Brass or stainless steel.
 9. Process Temperature Rating: **35 to 281 deg F (2 to 138 deg C)**.
 10. Leakage: 0.1 percent of maximum flow.
 11. Rangeability: Varies with valve size between 6 and 10 to 1.
 12. Modified linear flow characteristic.
- E. Three-Way Globe Valves **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**:
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Johnson Controls, Controls Group; VG2000 series.
 - b. <Insert manufacturer's name; product name or designation>.
 2. Globe Style: Mix flow pattern.
 3. Body: Cast iron complying with ASME B61.1, Class 125.
 4. End Connections: Flanged suitable for mating to ASME B16.5, Class 150 flanges.
 5. Bonnet: Bolted.
 6. Packing: PTFE cone-ring.

7. Plug: Top or bottom guided.
8. Plug, Seat, and Stem: Brass or stainless steel.
9. Process Temperature Rating: **35 to 281 deg F (2 to 138 deg C)**.
10. Leakage: 0.1 percent of maximum flow.
11. Rangeability: Varies with valve size between 6 and 10 to 1.
12. Modified linear flow characteristic.

F. Industrial-Grade Straight-Through Globe Valves **NPS 3/4 (DN 20)** and Smaller:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Fisher Valves & Instruments, Emerson Electric Co.; 24000 series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Globe Style: Single port.
3. Body: ASTM B 62 bronze complying with ASME B16.5, Class 250.
4. End Connections: Threaded.
5. Bonnet: Screwed or bolted.
6. Packing: PTFE V-ring.
7. Plug: Top or cage guided; balanced or unbalanced.
8. Plug, Seat, and Stem: 316 stainless steel, 17-4 PH stainless-steel cage.
9. Process Temperature Range: **Minus 20 to plus 400 deg F (Minus 29 to plus 204 deg C)**.
10. Ambient Operating Temperature: **Minus 20 to plus 150 deg F (Minus 29 to plus 71 deg C)**.
11. Leakage: FCI 70-2, Class IV.
12. Equal percentage flow characteristic.

G. Industrial-Grade Straight-Through Globe Valves **NPS 1 (DN 25)** and Larger:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Fisher Valves & Instruments, Emerson Electric Co.; ET series.
 - b. **<Insert manufacturer's name; product name or designation>**.
2. Globe Style: Single port.
3. Body: Cast iron or cast steel.
4. End Connections for **NPS 2 (DN 50)**: Threaded.
5. End Connections for **NPS 2-1/2 (DN 65)** and Larger: Raised face flanged.
6. Bonnet: Bolted.
7. Packing: PTFE V-ring.
8. Plug: Cage guided and unbalanced.
9. Plug, Seat, and Stem: 416 stainless-steel plug and seat, 17-4 PH stainless-steel cage and 316 stainless-steel stem.
10. Valve Stem: Thread and pin stem to plug.
11. Valve Stem Finish: Polished to 5 microinches rms or less.
12. Plug and Seat Surfaces: Hardened facing.
13. Process Temperature Range: **Zero to 450 deg F ((Minus 18 to plus 232 deg C))**.

14. Ambient Operating Temperature: **Minus 20 to plus 150 deg F** (Minus 29 to plus 71 deg C).
15. Leakage: FCI 70-2, [Class IV] [Class V] [Class VI].
16. Flow Characteristic: [Equal percentage] [Linear] [Quick opening].

H. Pressure-Independent Globe Valves **NPS 6 (DN 150)** and Smaller.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hydronic Components, Inc. (HCi); 91, 93, and 94F series or comparable product by one of the following:
 - a. Jomar Hydronics
 - b. <Insert manufacturer's name>.
2. Performance:
 - a. Pressure Rating: **360 psig** (2482 kPa) for **NPS 1/2 - 1-1/4 (DN 15 - 32)** and **360 psig** (2482 kPa) for **NPS 2 - 6 (DN 50 - DN 150)**.
 - b. Close-off pressure of **200 psig** (1379 kPa).
 - c. Process Temperature Range: Between **14 to 248 212 deg F** (minus 10 to plus 120 deg C).
 - d. Rangeability: 100 to 1.
3. Integral Pressure Regulator: To regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of **5 to 58 psig** (34 to 400 kPa).
4. Body: Forged brass, or ductile iron, and with threaded or flange ends.
5. Presetting **NPS 1/2 - 1-1/4 (DN 15 - 32)** have an externally adjustable max flow presetting dial. For **NPS 2 - 6 (DN 50 - DN 150)** max flow is set via actuator.
6. Flow Characteristic: Equal percentage and/or linear.

2.5 SOLENOID VALVES

A. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**

1. ASCO Valve, Inc.; 8210 series.
2. <Insert manufacturer's name; product name or designation>.

B. Description:

1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
3. Manual override capable.
4. Heavy-duty assembly.
5. Body: [Brass] [or] [stainless steel].
6. Seats and Discs: NBR or PTFE.
7. Solenoid Enclosure: NEMA 250, Type 4.

CONTROL VALVES

2.6 SELF-CONTAINED TEMPERATURE REGULATING VALVE

- A. Products: Subject to compliance with requirements, **[provide the following]** **[provide one of the following]** **[available products that may be incorporated into the Work include, but are not limited to, the following]:**
1. Jordan Valve, a division of Richards Industries; Mark 80 series.
 2. **<Insert manufacturer's name; product name or designation>.**
- B. Description:
1. Self-contained and self-operated temperature regulating valve. Direct acting or reverse acting as required by application.
 2. Direct Acting: A rise in temperature at the sensing bulb vaporizes some of the liquid in the bulb, forcing the remaining liquid through a capillary to apply pressure at the diaphragm, in turn closing the valve. The valve shall fail open.
 3. Reverse Acting: A rise in temperature at the sensing bulb vaporizes some of the liquid in the bulb, forcing the remaining liquid through a capillary to apply pressure at the diaphragm, in turn opening the valve. The valve shall fail close.
 4. Body: Carbon steel.
 5. Trim and Seats: 300 series stainless steel.
 6. Yoke: Cast iron.
 7. Actuator: 300 series stainless steel.
 8. End Connections: Threaded.
 9. Capillary, Bulb, and Armor: 300 series stainless steel.
 10. Thermal Fill Material: Match to the temperature range.
 11. Thermowell: Type 316 stainless-steel thermowell sized to fit the bulb and pipe.
- C. Operational Characteristics: Control flow from between 5 to 100 percent of rated capacity.
- D. Interchangeable trim for one size smaller.
- E. Valve Leakage: Comply with FCI 70-2, Class IV.
- F. Temperature Range: Match application.
1. Drains from Hot Equipment to Sanitary Sewer System: **105 to 165 deg F ((40 to 74 deg C))**.
 2. **<Insert description of applications>.**
- G. Valve Size: Size to pass the design flow required with not more than 95 percent of the stem lift while operating at design pressure.

2.7 PNEUMATIC CONTROL VALVE ACTUATORS

- A. Actuators for Hydronic Control Valves: Shutoff against system pump shutoff head.
- B. Actuators for Steam Control Valves: Shutoff against **[1.2]** **[1.5]** **<Insert number>** times steam design pressure.

CONTROL VALVES

- C. Position indicator and graduated scale on each actuator.
- D. Provide diaphragm action (air-to-open, air-to-close), as required by the sequence of operation, in the event of air supply failure.
- E. For each modulating control valve, provide a positive positioner with the valve actuator. The positioners shall operate on a 3- to 15-psig (21- to 103-kPa) input signal unless otherwise required to satisfy control sequences of operation. Integrally mount each positioner with an air regulator, air set, and gauges for supply, input and output. The positioner shall have the following performance characteristics:
 - 1. Linearity: Plus or minus 1 percent of the output signal span.
 - 2. Hysteresis: 0.5 percent of span.
- F. Diaphragms shall be replaceable.
- G. Actuator Construction:
 - 1. Cast-iron or steel diaphragm casing and plate. Cast aluminum is acceptable on valves NPS 4 ((DN 100)) and smaller.
 - 2. Cast iron or steel yoke. Cast aluminum is acceptable on valves NPS 4 ((DN 100)) and smaller.
 - 3. Reinforced synthetic rubber or nitrile diaphragm.
 - 4. Steel or steel alloy spring, stem, and spring adjuster.
- H. Rate actuators for not less than 1.2 times the main air pressure to the valve, minimum 30 psig ((207 kPa)).

2.8 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

- A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
- B. Actuators for Steam Control Valves: Shutoff against [1.2] [1.5] <Insert number> times steam design pressure.
- C. Position indicator and graduated scale on each actuator.
- D. Type: Motor operated, with or without gears, electric and electronic.
- E. Voltage: [Voltage selection delegated to professional designing control system] [24-V ac] [120-V ac] <Insert requirement>.
- F. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
- G. Function properly within a range of 85 to 120 percent of nameplate voltage.
- H. Construction:

CONTROL VALVES

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
 3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- I. Field Adjustment:
1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
 2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
- J. Two-Position Actuators: Single direction, spring return or reversing type.
- K. Modulating Actuators:
1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 2. Control Input Signal:
 - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
 - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for [~~zero- to 10-~~] [~~or~~] [~~2- to 10-~~]V dc [~~and~~] [~~4- to 20-mA~~] signals.
 - c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
 - d. Programmable Multi-Function:
 - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- L. Position Feedback:
1. [**Equip**] [**Where indicated, equip**] two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of [**open**] [**and**] [**close**] position.
 2. [**Equip**] [**Where indicated, equip**] modulating actuators with a position feedback through [**current**] [~~or~~] [**voltage**] signal for remote monitoring.
 3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

M. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

N. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

O. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

P. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [**minus 20 to plus 120 deg F ((minus 29 to plus 49 deg C))**] <Insert temperature range>.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from [**5 to 95**] <Insert number(s)> percent relative humidity, non-condensing.

Q. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

R. Stroke Time:

1. Operate valve from fully closed to fully open within [**15**] [**60**] [**75**] [**90**] [**150**] <Insert number> seconds.
2. Operate valve from fully open to fully closed within [**15**] [**60**] [**75**] [**90**] [**150**] <Insert number> seconds.
3. Move valve to failed position within [**5**] [**15**] [**30**] <Insert number> seconds.
4. Select operating speed to be compatible with equipment and system operation.

S. Sound:

1. Spring Return: 62 dBA.

2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

- A. Control Valves:
 1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
 2. **<Insert system> System, <Insert unique application>, Two-Way Applications Controlled by Flow: [Ball valves with single port and characterized disk] [Ball valves with single port and segmented ball] [Ball valves with full ball and characterized V-notch] [Industrial-grade ball valves] [Pressure-independent ball valves] [Butterfly-style valves, commercial-grade, two-way valves] [Butterfly-style valves, industrial-grade valves] [Globe-style, two-way valves] [Globe-style, industrial-grade, straight-through valves] [Pressure-Independent globe valves].**
 3. **<Insert system> System, <Insert unique application>,Two-Way Applications Controlled by Pressure: [Ball valves with single port and characterized disk] [Ball valves with single port and segmented ball] [Ball valves with full ball and characterized V-notch] [Industrial-grade ball valves] [Pressure-independent ball valves] [Butterfly-style valves, commercial-grade, two-way valves] [Butterfly-style valves, industrial-grade valves] [Globe-style, two-way valves] [Globe-style, industrial-grade, straight-through valves] [Pressure-Independent globe valves].**
 4. **<Insert system> System, <Insert unique application>, Two-Way Applications Controlled by Temperature: [Ball valves with single port and characterized disk] [Ball valves with single port and segmented ball] [Ball valves with full ball and characterized V-notch] [Industrial-grade ball valves] [Pressure-independent ball valves] [Butterfly-style valves, commercial-grade, two-way valves] [Butterfly-style valves, industrial-grade valves] [Globe-style, two-way valves] [Globe-style, industrial-grade, straight-through valves] [Solenoid valves] [Self-contained temperature regulating valves].**
 5. **<Insert system> System, <Insert unique application>, Three Way, Controlled by Temperature: [Ball valves with two ports and characterized disk] [Ball valves with**

CONTROL VALVES

segmented ball, three-way pattern] [Butterfly-style valves, commercial-grade, three-way valves] [Globe-style, three-way valves].

6. Steam System, <Insert unique application>, Two Way, Controlled by Temperature: **[Ball valves with single port and segmented ball] [Ball valves with full ball and characterized V-notch] [Industrial-grade ball valves] [Globe-style, two-way valves] [Globe-style, industrial-grade, straight-through valves].**

3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <Insert value> force.
- D. Provide ceiling, floor, roof, and 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.
- E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.
- F. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- H. Corrosive Environments:
1. Use products that are suitable for environment to which they will be subjected.
 2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
 - a. Laboratory exhaust airstreams.
 - b. Process exhaust airstreams.
 3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.

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

3.4 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 CONTROL VALVES

- A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
- B. Install flanges or unions to allow drop-in and -out valve installation.
- C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.
 1. **<Insert applications>**.
- D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than **[NPS 2 ((DN 50))]** **[NPS 4 ((DN 100))]** **<Insert nominal pipe size>**.
- E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than **[NPS 1 (DN 25)]** **[NPS 2 ((DN 50))]** **<Insert nominal pipe size>**.
- F. Valve Orientation:
 1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 2. Install valves in a position to allow full stem movement.
 3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

CONTROL VALVES

G. Clearance:

1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least **12 inches (300 mm)** of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. 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."
- B. Install engraved phenolic nameplate with valve identification on valve[**and on face of ceiling directly below valves concealed above ceilings**].

3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

CONTROL VALVES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11