SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball-style control valves.
2. Butterfly-style control valves.
3. Globe-style control valves.
4. Pressure-independent control valves.
5. Solenoid valves.
6. Electric and electronic control valve actuators.
7. Pneumatic control valve actuators.

B. Related Requirements:

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

1.2 DEFINITIONS

A. Cv: Valve coefficient.

B. DDC: Direct digital control.

C. EPT: Ethylene-propylene terpolymer rubber.

D. HNBR: Hydrogenated nitrile butadiene rubber.

E. NBR: Nitrile butadiene rubber.

F. PEEK: Polyether Ether Ketone rubber.

G. PTFE: Polytetrafluoroethylene.

H. 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.

I. RTFE: Glass-fiber-reinforced PTFE.

J. TFM: A chemically modified PTFE.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Ball-style control valves.
2. Butterfly-style control valves.
3. Globe-style control valves.
4. Pressure-independent control valves.
5. Solenoid valves.
6. Electric and electronic control valve actuators.
7. Pneumatic control valve actuators.

B. Product Data Submittals: For each product.

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.

C. Shop Drawings:

1. Include plans, elevations, sections, and 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.

1.4 INFORMATIONAL SUBMITTALS

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

1. Control valve installation location indicated 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.

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. Code Compliance: Comply with governing energy code.

D. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

E. Backup Power Source: Serve control valve actuators from a backup power source where associated with systems and equipment served by a backup power source.

F. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

G. Selection Criteria:

1. Suitable for operation throughout full range of system operating conditions encountered.

    a. Chilled Water/Glycol: 150 psig 32-65 deg F.
    b. Condenser Water: 150 psig 100 deg F.
    c. Heating Hot Water: 150 psig 130-180 deg F.
    d. Steam: 30 psig 212-500 deg F

2. Steam Condensate Return: 50 psig 250 deg FControl Valve Leakage: FCI 70-2, or less leakage, unless otherwise indicated.
3. Control Valve Pattern: as indicated on Drawings.
4. Control Valve Flow Characteristics, Unless Otherwise Indicated:

    a. Modulating, Two-Way Pattern: Equal percentage.
    b. Modulating Three-Way Pattern: Linear flow. Total flow through the valve to be constant regardless of the valve's position.
    c. Modulating Butterfly Valves: Linear flow or Equal percentage.

5. Fail-Safe Positions, Unless Otherwise Indicated:

    a. Chilled Water: Close.
    b. Condenser Water: Close.
    c. Heating Hot Water: Last position.
    d. Steam: Close.

6. Stable Operation: Select control valves and actuators for stable operation throughout full range of operation, from design Cv at design flow to minimum Cv.
7. Control Valve Styles:

    a. Hydronic Systems:

        1) Pipe Sizes NPS 2 (DN 50) and Smaller: Ball- or globe-style control valves.
        2) Pipe Sizes Larger than NPS 2 (DN 50): butterfly- or globe-style control valves.

    b. Steam Systems: Use globe-style control valves.

H. Sizing Criteria: Unless otherwise indicated, select control valve size using the following:

1. ISA Standards:

    a. Control Valve Sizes and Flow Coefficients: ISA 75.01.01.
    b. Control Valve Characteristics and Rangeability: ISA 75.11.01.

2. Correction Factors: Consider viscosity, flashing, and cavitation corrections when selecting control valves.
3. Ball-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.
4. Butterfly-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.
5. Globe-Style Control Valves: Select valve size to pass the design Cv at design flow with not more than 95 percent of stem travel.
6. Modulating Control Valves in Hydronic Systems:

    a. Select modulating control valve sizes at terminal equipment for a design Cv based on a pressure drop of 7 psig at design flow.
    b. Calculate control valve minimum Cv at 10 percent of control valve design flow, with a coincident pressure differential equal to controlled coil pressure drop. .

7. Modulating Control Valves Steam Systems: Select modulating valve sizes for steam service with a pressure drop at design flow equal to lesser of the following:

    a. 50 percent of the valve inlet pressure.

8. Two-Position Valves: Select two-position control valves for full pipeline size.

I. Pneumatic, Two-Position Control Valve Opening and Closing Characteristic:

1. Provide a smooth opening and closing characteristic slow enough to avoid an excessive rapid change in system pressure and potential water hammer.
2. Provide an adjustable opening time (full closed to full open) and an adjustable closing time (full open to full closed) ranging from zero to 30 seconds. Make opening and closing times independently adjustable.

J. Pneumatic Control Signal Distance Limitation: Not to exceed 100 ft. from controller. For longer distances, provide an electric/electronic control signal to the valve/actuator and an electric solenoid valve or electro-pneumatic transducer locally at the valve/actuator to convert the control signal to pneumatic.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Threaded Ends, Two Way:

1. Source Limitations: Obtain threaded end two-way ball valves from single manufacturer.
2. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Modified equal percentage.
    d. Leakage: FCI 70-2, or less.
    e. Hydronic Pressure:

        1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal 600 psig.
        2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal 400 psig.
        3) Close-off Pressure: 200 psig.
        4) Pressure Differential (Maximum): 50 psig.

    f. Hydronic Process Temperature Range: 0 to 250 deg F.
    g. Saturated Steam Pressure: 50 psig for stainless steel body control valves.

3. Construction for Ball Valves with Threaded Ends, Two Way:

    a. Size Range: NPS 1/2 to NPS 2.
    b. Body: Cast bronze or stainless steel.
    c. End Connections: Female threaded (NPT) ends.
    d. Ball: Stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Stem and Stem Extension:

        1) Material to match ball.
        2) Blowout-proof design.
        3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
        4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

    g. 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.

B. Ball Valves with Flanged Ends, Two Way:

1. Source Limitations: Obtain flanged end two-way ball valves from single manufacturer.
2. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Modified equal percentage.
    d. Leakage: FCI 70-2, Class VI or less.
    e. Hydronic Pressure:

        1) Rating: ASME B16.34, Class 150 or 300 required by application.
        2) Close-off Pressure: Equal to rating.
        3) Pressure Differential (Maximum): 50 psig.

    f. Hydronic Process Temperature Range: 0 to 250 deg F.
    g. Saturated Steam Pressure:

        1) Rating: Maximum 150 psig
        2) Close-off Pressure: Equal to pressure rating.
        3) Differential (Maximum): 50 percent if the inlet pressure to the valve.

3. Standards for Ball Valves with Flanged Ends, Two Way: ASME B16.34, MSS SP-72.
4. Features:

    a. Full or standard port.
    b. Replaceable ball, seat and stem packing.
    c. Pressure equalized between body cavity and the line flow.
    d. Mounting pad for actuator.

5. Construction:

    a. Size Range: NPS 1/2 to NPS 12.
    b. Body: Cast steel or stainless steel; two pieces.
    c. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges.
    d. Ball: Stainless steel; vented.
    e. Ball Seats: Reinforced PTFE.
    f. Stem: Material to match ball; blowout-proof design.
    g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure.

C. Ball Valves with Threaded Ends, Three Way:

1. Source Limitations: Obtain threaded end three-way ball valves from single manufacturer.
2. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Modified linear flow.
    d. Leakage: FCI 70-2, or less.

e. Hydronic Pressure:

1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal 600 psig.
2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal 400 psig.
3) Close-off Pressure: 200 psig.
4) Pressure Differential (Maximum): 50 psig.

f. Hydronic Process Temperature Range: 0 to 250 deg F.

3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or stainless steel.
c. End Connections: Female threaded (NPT) ends.
d. Ball: Stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

g. 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.

D. Ball Valves with Characterized Disk and Threaded Ends, Two Way:
1. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 75 percent open.
c. Flow Characteristic: Equal percentage.
d. Leakage: FCI 70-2, or less.
e. Hydronic Pressure:

1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal 600 psig.
2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal 400 psig.
3) Close-off Pressure: 200 psig.
4) Pressure Differential (Maximum): 50 psig.

f. Hydronic Process Temperature Range: 0 to 250 deg F.

3. Construction:

    a. Size Range: NPS 1/2 to NPS 2.
    b. Body: Cast bronze or forged brass.
    c. End Connections: Female threaded (NPT) ends.
    d. Ball: 300 series stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Characterizing Disk: ETFE Tefzel or stainless steel.
    g. Stem and Stem Extension:

        1) Material to match ball.
        2) Blowout-proof design.
        3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
        4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

    h. 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.

E. Ball Valves with Characterized Disk and Flanged Ends, Two Way:

1. Source Limitations: Obtain two-way ball valves, with characterized disk and flanged ends, from single manufacturer.
2. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: FCI 70-2, or less.
    e. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.1, Class B.
        2) Close-off Pressure:

            a) Class 125: 175 psig.
            b) Class 250: 310 psig.

        3) Pressure Differential (Maximum): 50 psig.

    f. Hydronic Process Temperature Range: 0 to 250 deg F.

3. Construction:

    a. Size Range: NPS 2-1/2 to NPS 6.
    b. Body: Cast iron, Class B in accordance with ASME B16.1.
    c. End Connections: Flanged, Class 125 or 250 in accordance with ASME B16.1.
    d. Ball: Stainless steel.

e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension: Material to match ball; blowout-proof design.
h. 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.

F. Ball Valves with Characterized Disk and Threaded Ends, Three Way:

1. Source Limitations: Obtain three-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 75 percent open.
c. Flow Characteristics:

1) A-Port: Equal percentage.
2) B-Port: Modified for constant common port flow.

d. Leakage: FCI 70-2, or less for A-port; one percent for B-port.
e. Hydronic Pressure:

1) Rating for Sizes NPS 1 (DN 25) and Smaller: Nominal 600 psig.
2) Rating for Sizes NPS 1-1/4 through NPS 2 (DN 32 through DN 50): Nominal 400 psig.
3) Close-off Pressure: 200 psig.
4) Pressure Differential (Maximum): 50 psig.

f. Hydronic Process Temperature Range: 0 to 250 deg F.

3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: ETFE, Tefzel or stainless steel.
g. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

h. 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.

G. Ball Valves with Full Ball and Characterized V-Notch, Two Way:

1. Source Limitations: Obtain two-way ball valves, with full ball and characterized v-notch, from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 80 percent open.
c. Flow Characteristic: Equal percentage.
d. Leakage: FCI 70-2, Class VI.
e. Hydronic Pressure:

1) Rating:

a) Sizes NPS 2 (DN 50) and Smaller: ASME B16.34, Class 300 or 600.
b) Larger Sizes: ASME B16.34, Class 150 or 300 as required by application.

2) Close-off Pressure: Equal to rating.
3) Pressure Differential (Maximum): Approximately 1/3 inlet pressure.

f. Hydronic Process Temperature Rating: 0 to 250 deg F.
g. Saturated Steam Pressure:

1) Rating: Maximum 50 psig
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Differential (Maximum): 50 percent of inlet pressure.

3. Standards: ASME B16.34, MSS SP-72.
4. Features:

a. Full or standard port.
b. Replaceable ball, seat, shaft bushings, and packing.
c. Pressure equalized between body cavity and the line flow.
d. Universal mounting pad complying with ISO 5211 for actuator mounting.

5. Construction:

a. Size Range: NPS 1/2 to NPS 12.
b. Sizes NPS 2 (DN 50) and Smaller:

1) End Connections: Female threaded (NPT) ends complying with ASME B1.20.1 or flanged ends suitable for mating to ASME B16.5 flanges.
2) Stem Seals: 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.

c. Sizes Larger than NPS 2 (DN 50):

1) Stem Seals: 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.

2) Flanged ends suitable for mating to ASME B16.5 flanges.

d. Face-to-Face Dimension: ASME B16.10 short or long pattern, or ISA S75.08.02.
e. Body: stainless steel; two- or three-piece design.
f. Ball: Stainless steel.
g. Seat: Reinforced PTFE, TFM, PEEK.
h. Shaft: Stainless steel.

6. Label each valve with following:

a. Manufacturer's name, model number, and serial number.
b. Body size.
c. Flow directional arrow.

2.3 BUTTERFLY-STYLE CONTROL VALVES

A. Butterfly Valves with Resilient Seats, Two Way:

1. Source Limitations: Obtain two-way butterfly valves, with resilient seats, from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Linear or modified equal percentage.
c. Leakage: Bubble tight.
d. Hydronic Pressure:

1) Rating: Minimum 150 psig.
2) Shutoff Pressure: Minimum 150 psig.
3) Differential (Maximum): 50 psig

e. Hydronic Process Temperature Range: 0 to 225 deg F.

3. Standards: MSS SP-67.
4. Features:

a. Bidirectional, dead end service with downstream flange removed.

b. Extended neck of body to accommodate up to 2-inch-thick insulation.
c. Replaceable disc, shaft bearings/bushings and seat.

5. Construction:

a. Size Range: NPS 2 to NPS 12
b. Body: Cast iron or ductile iron; single flange, fully lugged and suitable for mating to ASME B16.5 flanges.
c. Disc: Aluminum bronzeor stainless steel.
d. Seat: Reinforced EPDM.
e. Stem(s): Stainless steel.
f. Stem Bushings: Reinforced PTFE.
g. Corrosion-resistant nameplate indicating the following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Body and trim materials.
4) Flow arrow.

B. High-Performance Butterfly Valves, Two Way:

1. Source Limitations: Obtain two-way high-performance butterfly valves from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Linear or modified equal percentage.
c. Leakage: FCI 70-2, Class VI.
d. Hydronic Pressure:

1) Rating: ASME B16.34, Class 150 or 300 as required by application.
2) Close-off Pressure: Equal to rating.
3) Pressure Differential (Maximum): 50 psig.

e. Hydronic Process Temperature Rating: 0 to 250 deg F.
f. Saturated Steam Pressure

1) Rating: Maximum 150 psig
2) Close-off Pressure: Equal to pressure rating.
3) Differential (Maximum): 50 psig.

3. Standards: ASME B16.34, MSS SP-68.
4. Features:

a. Bidirectional, end-of-line service with downstream flange removed.
b. Extended neck of body to accommodate up to 2-inch-thick insulation.
c. Replaceable seat, disc and shaft bearings/bushings.

5. Construction:

a. Size Range: NPS 2-1/2 to NPS 36

b. Body: Cast steel or stainless steel; single flange, fully lugged and suitable for mating to ASME B16.5 or ASME B16.47 flanges.
c. Disc: Stainless steel.
d. Seat: Reinforced PTFE with stainless steel retaining ring.
e. Stem(s): Stainless steel.
f. Stem Bearings: Stainless steel.
g. Stem Packing: PTFE.
h. Corrosion-resistant nameplate indicating the following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Body and trim materials.
4) Body rating.
5) Arrow indicating direction of flow.

2.4 GLOBE-STYLE CONTROL VALVES

A. General Requirements:

1. Body Dimensions: Comply with ISA 75.08.01.
2. Field Service: Construct the valves to be serviceable from the top with replaceable seats and plugs.
3. Field-Interchangeable Trim:

a. Cage Guided Valves: Available with field-interchangeable trim for different valve flow characteristics, such as equal percentage, linear, and quick opening.
b. Industrial Valves NPS 1and Larger: Available with reduced trim one nominal size smaller.

4. Nameplate: Corrosion-resistant, indicating the following:

a. Manufacturer's name, model number, and serial number.
b. Body and trim size.
c. Arrow indicating direction of flow.

B. Globe Valves NPS 2 and Smaller, Two Way:

1. Source Limitations: Obtain two-way globe valves, NPS 2 and smaller, from single manufacturer.
2. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Equal percentage.
c. Leakage: FCI 70-2, Class VI or 0.05 percent of maximum flow for stainless steel trim.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Pressure Differential (Maximum): 30 psig for sizes through NPS 2.

e. Saturated Steam Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Pressure Differential (Maximum): 100 psig for control valves with stainless steel trim.

f. Ambient Operating Temperature: 35 to 150 deg F.
g. Process Temperature Range:

1) Hydronic: 35 to 248 deg F.
2) Steam: Temperature at saturated steam pressure.

3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass; ASME B16.15, Class 250.
c. End Connections: Female NPT threaded ends.
d. Bonnet: Bronze or brass, threaded.
e. Plug: Top guided.

f. Stainless Steel Trim:

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

C. Globe Valves NPS 2 and Smaller, Three Way:

1. Source Limitations: Obtain three-way globe valves, NPS 2 and smaller, from single manufacturer.
2. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Linear.
c. Leakage: FCI 70-2, Class VI or 0.05 percent of maximum flow for stainless steel trim.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Pressure Differential (Maximum): 35 psig.

e. Ambient Operating Temperature: 35 to 150 deg F.
f. Hydronic Process Temperature Range: 35 to 248 deg F.

3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass; ASME B16.15, Class 250.

c. End Connections: Female NPT threaded ends.
d. Bonnet: Bronze or brass, threaded.
e. Plug: Top guided.
f. Brass Trim:

1) Packing: Self-adjusting Ethylene Propylene Rubber (EPR) rings or PTFE V-ring.
2) Plug: Brass
3) Seat: Bronze or molded elastomeric disk.
4) Stem: Stainless steel.

D. Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Two Way:

1. Source Limitations: Obtain two-way globe valves, NPS 2-1/2 to NPS 6, from single manufacturer.
2. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Equal percentage or linear.
c. Leakage: FCI 70-2, Class IV.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.1, Class 125 or 250 as required by application.
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): 25 psig.

e. Hydronic Process Temperature: 35 to 280 deg F.
f. Saturated Steam Pressure:

1) Rating: In accordance with ASME B16.1, Class 125 or 250 as required by application.
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): 5 psig.

g. Ambient Operating Temperature: 0 to 150 deg F.

3. Construction:

a. Size Range: NPS 2-1/2 to NPS 6.
b. Body: Cast iron; ASME B16.1.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Bonnet: Cast iron; bolted.
e. Plug: Top or bottom guided.
f. Brass or Bronze Trim:

1) Packing: EPT rings or PTFE V-ring.
2) Plug: Brass or bronze.
3) Seat: Brass or bronze.
4) Stem: Stainless steel.

g. Stainless Steel Trim (Steam):

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

E. Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Three Way:

1. Source Limitations: Obtain three-way globe valves, NPS 2-1/2 to NPS 6, from single manufacturer.
2. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Linear.
c. Leakage: FCI 70-2, Class IV.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.1, Class 125 or 250 as required by application.
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): 30 psig.

e. Hydronic Process Temperature: 35 to 280 deg F.
f. Ambient Operating Temperature: 0 to 150 deg F.

3. Construction:

a. Size Range: NPS 2-1/2 to NPS 6.
b. Body: Cast iron; ASME B16.1.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Bonnet: Cast iron; bolted.
e. Plug: Top or bottom guided.
f. Brass or Bronze Trim:

1) Packing: EPT rings or PTFE V-ring.
2) Plug: Brass or bronze.
3) Seat: Brass or bronze.
4) Stem: Stainless steel.

g. Stainless Steel Trim(Steam):

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

F. Industrial-Grade Globe Valves NPS 3/4 and Smaller, Two Way:

1. Source Limitations: Obtain two-way industrial-grade globe valves, NPS 3/4and smaller, from single manufacturer.

2. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Equal percentage or linear.
    c. Leakage: FCI 70-2, Class IV.
    d. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.15, Class 250.
        2) Close-off Pressure: Equal to pressure rating.
        3) Pressure Differential (Maximum): 100 psig.

    e. Hydronic Process Temperature Range: 0 to 400 deg F.
    f. Saturated Steam Pressure:

        1) Rating: In accordance with ASME B16.15, Class 250.
        2) Close-off Pressure: Equal to pressure rating.
        3) Pressure Differential (Maximum): 100 psig.

    g. Ambient Operating Temperature: Minus 20 to 150 deg F.

3. Construction:

    a. Size Range: NPS1/2 to NPS 3/4.
    b. Body: Bronze.
    c. End Connections: Female NPT threaded.
    d. Bonnet: Bronze; screwed or bolted.
    e. Packing: PTFE V-ring.
    f. Plug: Top or cage guided; balanced or unbalanced.
    g. Plug and Stem: Stainless steel.
    h. Seat: Stainless steel with PTFE insert.

G. Industrial-Grade Globe Valves NPS 1 (DN 25) and Larger, Two Way:

1. Source Limitations: Obtain two-way industrial-grade globe valves from single manufacturer.
2. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Linear or quick opening.
    c. Leakage: FCI 70-2, Class IV.
    d. Hydronic Pressure:

        1) Rating for Cast-Iron Body Valves: In accordance with ASME B16.1, Class 125 or 250, as required by application.
        2) Rating for Cast-Steel and Stainless Steel Body Valves: In accordance with ASME B16.34, Class 150 or 300, as required by application.
        3) Close-off Pressure: Equal to pressure rating.
        4) Pressure Differential (Maximum): 100 psig.

    e. Hydronic Process Temperature: 0 to 200 deg F.

f. Saturated Steam Pressure:

1) Rating for Cast-Iron Valves: In accordance with ASME B16.1, Class 125 or 250, as required by application.
2) Rating for Cast-Steel and Stainless Steel Valves: In accordance with ASME B16.34, Class 150 or 300, as required by application.
3) Close-off Pressure: Equal to pressure rating.
4) Pressure Differential (Maximum): 100 psig.

g. Ambient Operating Temperature: Minus 20 to 150 deg F.

3. Features:

a. Interchangeable, restricted-capacity and full-size trim.
b. Interchangeable, cage and plug styles for three different flow characteristics: equal percentage, linear and quick opening.
c. Trim options to prevent damage caused by cavitation where required by application.

4. Construction:

a. Size Range: NPS 1 to NPS 30.
b. Body: Cast ironor stainless steel.
c. End Connections:

1) NPS 2 and Smaller: Female NPT threaded or flanged suitable for mating to ASME B16.5 flanges.
2) NPS 2-1/2 and Larger: Raised face flanges suitable for mating to ASME B16.5 or ASME B16.47 flanges.

d. Bonnet: Bolted, material to match body.
e. Packing: PTFE V-ring.
f. Plug: Cage guided and balanced.
g. Plug, Seat, Cage, and Stem: Stainless steel plug and seat with hardened facing, stainless steel cage and stem.
h. Stem: Thread and pin stem to plug; polished finish.

2.5 PRESSURE-INDEPENDENT CONTROL VALVES

A. Pressure-Independent Ball Valves NPS 2 (DN 50) and Smaller:

1. Source Limitations: Obtain pressure-independent ball valves, NPS 2and smaller, from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Equal percentage.
c. Leakage: Zero.
d. Hydronic Pressure Rating: 360 psig.
e. Hydronic Close-off Pressure: 200 psig.

f. Process Temperature Range: Between 35 to 250 deg F.

3. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by one of the follow methods:

a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.
b. Integral Electronic Regulation: Electronic flow meter and control signal to maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.

1) Flow Measurement: Within 2 percent of actual reading.
2) Flow Control: Within 5 percent of set point.
3) Pressure Differential Range: 5 to 50 psig.

4. Construction:

a. Body: Bronze or forged brass.
b. End Connections: Female threaded (NPT) ends.
c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
d. Diaphragm: HNBR or EPDM.
e. Ball: Chrome-plated brass or stainless steel.
f. Seats: RTFE.
g. Stem and Stem Extension: Material to match ball; blowout-proof design.
h. Stem Seal: RTFE packing ring stem seal with 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 equivalent cycle endurance can be achieved.

B. Pressure-Independent Ball Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150):

1. Source Limitations: Obtain pressure-independent ball valves NPS 2-1/2 to NPS 6 from single manufacturer.
2. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Equal percentage.
c. Leakage: Zero.
d. Hydronic Pressure Rating: In accordance with ASME B16.1, Class 125 or 250, as required by application.
e. Hydronic Close-off Pressure:

1) Class 125: 175 psig.
2) Class 250: 310 psig.

f. Process Temperature Range: Between 35 to 250 deg F.

3. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by one of the follow methods:

    a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.
    b. Integral Electronic Regulation: Electronic flow meter and control signal to maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.

        1) Flow Measurement: Within 2 percent of actual reading.
        2) Flow Control: Within 5 percent of set point.
        3) Pressure Differential Range: 5 to 50 psig.

4. Construction:

    a. Body: Cast iron; ASME B16.1.
    b. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
    c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
    d. Ball: Stainless steel.
    e. Seats: RTFE.
    f. Stem and Stem Extension: Material to match ball; blowout-proof design.
    g. Stem Seal: Reinforced PTFE packing ring stem seal with 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 equivalent cycle endurance can be achieved.

C. Pressure-Independent Globe Valves with Threaded Ends:

1. Source Limitations: Obtain threaded end pressure-independent globe valves from single manufacturer.
2. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Equal percentage or linear.
    c. Flow Control: Within 5 percent of set point.
    d. Leakage: FCI 70-2, Class IV.
    e. Hydronic Pressure Rating: 250 psig.
    f. Hydronic Close-off Pressure: 140 psig.
    g. Process Temperature Range: Between 35 to 240 deg F.

3. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of 5 to 60 psig.
4. Construction:

    a. Size Range: NPS 1/2 to NPS 2.
    b. Body: Bronze or forged brass.
    c. End Connections: Female threaded (NPT) ends.

d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
e. Diaphragm: HNBR or EPDM.
f. O-Rings: EPDM.
g. Plug: Brass or stainless steel.
h. Spring: Stainless steel.
i. Stem: Stainless steel.

D. Pressure-Independent Globe Valves with Flanged Ends:

1. Source Limitations: Obtain flanged end pressure-independent globe valves from single manufacturer.
2. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Equal percentage or linear.
c. Flow Control: Within 5 percent of set point.
d. Leakage: FCI 70-2, Class IV.
e. Hydronic Pressure Rating: 175 psig.
f. Hydronic Close-off Pressure: 90 psig.
g. Process Temperature Range: Between 35 to 240 deg F.

3. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of 5 to 60 psig.
4. Construction:

a. Size Range: NPS 2-1/2 to NPS 6.
b. Body: Cast iron or ductile iron.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
e. Diaphragm: HNBR or EPDM.
f. O-Rings: EPDM.
g. Plug: Brass or stainless steel.
h. Spring: Stainless steel.
i. Stem: Stainless steel.

2.6 SOLENOID VALVES

A. Brass and Bronze Solenoid Valves, Two Way:

1. Source Limitations: Obtain two-way brass and bronze solenoid valves from single manufacturer.
2. Performance:

a. Ambient Operating Temperature: 32 to 125 deg F.
b. Leakage: Bubbletight.

c. Hydronic Operating Pressure:

1) Maximum: 125 psig.
2) Minimum Operating: 0 psig.

d. Hydronic Process Temperature Range: 0 to 250 deg F.
e. Saturated Steam Pressure: 125 psig.
f. Speed of Response: Manufacturer's standard design.
g. Voltage: Coordinate with field power source.

3. Features:

a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.
b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
c. Override: Integral manual override.

4. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Brass or bronze.
c. End Connections: Female threaded (NPT) ends.
d. Discs and Seats: NBR, EPDM or PTFE.
e. Orifice: Select size for performance required by application.
f. Wetted Parts: Stainless steel.
g. Coil: Copper .
h. Coil Insulation: Class F.
i. Solenoid Enclosure: NEMA 250, Type 4 or Type 4Xor explosion proof per application.

B. Stainless Steel Solenoid Valves, Two Way:

1. Source Limitations: Obtain two-way stainless steel solenoid valves from single manufacturer.
2. Performance:

a. Ambient Operating Temperature: 32 to 125 deg F.
b. Leakage: Bubbletight.
c. Hydronic Operating Pressure:

1) Maximum: 150 psig.
2) Minimum Operating: 0 psig.

d. Hydronic Process Temperature Range: 0 to 250 deg F.
e. Speed of Response: Manufacturer's standard design.
f. Voltage: Coordinate with field power source.

3. Features:

    a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.
    b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
    c. Override: Integral manual override.

4. Construction:

    a. Size Range: NPS 1/2 to NPS 2.
    b. Body: Stainless steel.
    c. End Connections: Female threaded (NPT) ends.
    d. Discs and Seats: NBR, EPDM, or PTFE.
    e. Orifice: Select size for performance required by application.
    f. Wetted Parts: Stainless steel.
    g. Coil: Silver.
    h. Coil Insulation: Class F.
    i. Solenoid Enclosure: NEMA 250, As required by application.

2.7 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Furnish control valves with factory-installed actuators from control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

B. Actuators for Control Valves in Hydronic Systems: Select actuators to close off against system pump shutoff head.

C. Actuators for Control Valves in Steam Systems: Select actuators to close off against 1.5 times steam design pressure.

D. Type: Motor operated, with or without gears, electric and electronic.

E. Voltage:

1. Voltage selection is delegated to professional designing control system.
2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.

F. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. 100 up to 400 W: Ground steel gears, oil immersed; shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

G. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

H. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring-return or reversing type.

J. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

    a. Proportional: Actuator drives proportionally to input signal, modulates throughout its angle of rotation, and is suitable for zero to 10 or 2 to 10 V dc and 4 to 20 mA signals.

K. Position Feedback:

1. Equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. 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.

L. 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 nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. 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.

N. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve stem 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.

O. 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.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 or Type 4 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. NEMA 250, Type 7 or Type 9 for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.

Q. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation.

2.8 PNEUMATIC CONTROL VALVE ACTUATORS

A. Source Limitations:

1. Furnish control valves with factory-installed actuators by control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

B. Actuators for Control Valves in Hydronic Systems: Select actuators to close off against system pump shutoff head.

C. Actuators for Control Valves in Steam Systems: Select actuators to close off against 1.5 times steam design pressure.

D. Equip pneumatic modulating actuators with a positive positioner, having the following performance characteristics:

1. Linearity: Within 1 percent of output signal span.
2. Hysteresis: 0.5 percent of the span.

E. Provide each positioner with an integrally mounted air set and pressure gauges for supply, input, and output. Operate on a 3 to 15 psig input signal unless otherwise required by the application to comply with the control sequence of operation.

F. Rate actuators for a pressure of at least 1.1 times main supply air pressure to actuator, but not less than 25 psig.

G. Single-Action (Spring-Return) Diaphragm Actuators:

1. Travel: As required by application.

    a. Rotary travel for control of quarter-turn (0 to 90 degrees) control valves.
    b. Linear travel for control valves with linear stem travel.

2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

    a. Diaphragm: Reinforced synthetic rubber or nitrile. Provide actuators with replaceable diaphragms.
    b. Diaphragm Casing and Plate: Cast iron, steel, or cast aluminum.
    c. Spring, stem, and spring adjuster: Steel or steel alloy.
    d. Yoke: Cast iron, steel, or cast aluminum.

H. Double-Action (Air-to-Air) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (0 to 90 degrees) valves.
2. Fail-Safe Position (Loss of Air): Last position.
3. Construction:

    a. Body: Anodized extruded-aluminum alloy.
    b. End Caps: Cast-aluminum alloy.
    c. Pistons: Cast-aluminum alloy.
    d. Piston O-Ring Seals: NBR.
    e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
    f. Travel Stops: Adjustable, stainless steel.
    g. Fasteners: Stainless steel.

I. Single-Action (Spring-Return) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (0 to 90 degrees) control valves.
2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

    a. Body: Anodized extruded-aluminum alloy.
    b. End Caps: Cast-aluminum alloy.
    c. Pistons: Cast-aluminum alloy.
    d. Piston O-Ring Seals: NBR.
    e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
    f. Springs: Coated steel or steel alloy.
    g. Travel Stops: Adjustable, stainless steel.
    h. Fasteners: Stainless steel.

J. Provide actuator with adjustable stops for both maximum and minimum positions.

K. Local Manual Override: Where indicated, provide actuators with an external manual adjustment mechanism to allow manual positioning of the valve through the actuator.

L. Local Position Indication: Provide a position indicator and graduated scale on each actuator. Indicate open and closed travel limits.

M. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. Install actuator(s) in a supplemental enclosure with a heater and controller where required by application.

N. Position Feedback Signal:

1. Equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

O. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation.

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.

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 control valves and actuators, 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 seismic event, wind, or other forces common to the application.

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. Seal penetrations made in fire-rated and acoustically rated assemblies.

F. Fastening Hardware:

1. 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. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
3. 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.
4. 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 CONTROL VALVES

A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control 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. Drain Valves:

1. Install drain valves in piping upstream and downstream of each control valve larger than NPS 4.
2. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold.

D. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve.

E. Valve Orientation:

1. Where possible, install ball and globe valves that are 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.

F. 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 of clear space around valve and between valves and adjacent surfaces.

G. 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.

H. 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.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Use same designation at each end for each piece of wire, cable, and tubing 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. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

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 pneumatic 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 15 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