

SECTION 23 09 23.11 - CONTROL VALVES**PART 1 - GENERAL**

1.01 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 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.
 - 2. 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 differentials 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.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 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 manufacturer to size products where indicated as delegated

design.

- D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- E. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- G. Selection Criteria:
 - 1. Control valves shall be suitable for operation at following conditions:
 - a. Chilled Water: <Insert pressure and coincident temperature requirements>.
 - b. Heating Hot Water: <Insert pressure and coincident temperature requirements>.
 - 2. Fail positions unless otherwise indicated:
 - a. Chilled Water: Open.
 - b. Heating Hot Water: Open.
 - 3. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
 - 4. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 12' head at design flow unless otherwise indicated.
 - 5. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:
 - a. 50 percent of the valve inlet pressure.
 - b. 50 percent of the absolute steam pressure at the valve inlet.

2.02 BALL-STYLE CONTROL VALVES

- A. Ball Valves with Single Port and Characterized Disk:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Belimo Aircontrols (USA), Inc.
 - 2. Pressure Rating for NPS 1-inch and Smaller: Nominal 600 WOG.
 - 3. Pressure Rating for NPS 1 ½ -inch through NPS 2-inch: Nominal 400 WOG.
 - 4. Close-off Pressure: 200 psig.
 - 5. Process Temperature Range: Zero to 212 deg. F.
 - 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: 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Belimo Aircontrols (USA), Inc.
 - 2. Pressure Rating for NPS 1-inch and Smaller: Nominal 600 WOG.
 - 3. Pressure Rating for NPS 1 ½ -inch through NPS 2-inch: Nominal 400 WOG.
 - 4. Close-off Pressure: 200 psig.
 - 5. Process Temperature Range: Zero to 212 deg. F.
 - 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. Pressure-Independent Ball Valves NPS 2-inch and Smaller:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Belimo Aircontrols (USA), Inc.
 - b. HCI; Hydronics Components Inc.
 - 2. Performance:
 - a. Pressure Rating: 600 psig for NPS 1-inch and 400 psig for NPS 1 ½ -inch and NPS 2-inch.
 - b. Close-off pressure of 200 psig.
 - c. Process Temperature Range: Between Zero to 212 deg. F.
 - d. Rangeability: 100 to 1.
 - 3. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.
 - 4. Body: Forged brass, nickel plated, and with threaded ends.
 - 5. Ball: Chrome-plated brass.
 - 6. Stem and Stem Extension: Chrome-plated brass, blowout-proof design.
 - 7. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.
 - 8. Ball Seats: Reinforced PTFE.
 - 9. 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.
 - 10. Flow Characteristic: Equal percentage.

2.03 BUTTERFLY-STYLE CONTROL VALVES

- A. Commercial-Grade, Two-Way Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Keystone; Tyco Flow Control.
 - 2. Performance:
 - a. Bi-directional bubble tight shutoff at 250 psig.
 - 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Keystone; Tyco Flow Control.
 2. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
 3. Performance:
 - a. Bi-directional bubble tight shutoff at 250 psig.
 - 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.

2.04 SOLENOID VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ASCO Valve, Inc.
- 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.
 6. Seats and Discs: NBR or PTFE.
 7. Solenoid Enclosure: NEMA 250, Type 4.

2.05 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 1.5 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 the controls contractor and to be coordinated with the electrical contractor.
- 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:
 - 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 counterclockwise 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 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 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.
 - 2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 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 seconds.
 - 2. Operate valve from fully open to fully closed within 15 seconds.
 - 3. Move valve to failed position within 30 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

3.01 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. Hydronic System, Two-Way Applications Controlled by Temperature: Ball valves with single port and characterized disk or Butterfly-style valves, commercial-grade, two-way valves.
 - 3. Hydronic System, Three Way, Controlled by Temperature: Ball valves with two ports and characterized disk or Butterfly-style valves, commercial-grade, three-way valves.

3.02 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 250lb 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.

3.03 ELECTRIC POWER

- A. All electrical wiring for the control system shall be as specified in the Electrical Section of the Specifications and as required by local codes. The wiring shall be by this contractor. This contractor shall coordinate all power and voltage requirements.
- B. Furnish and install electrical power to products requiring electrical connections.
- C. Furnish and install circuit breakers. Comply with requirements in the electrical specifications.
- D. Furnish and install power wiring. Comply with requirements in the electrical specifications.
- E. Furnish and install raceways. Comply with requirements in the electrical specifications.

3.04 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.
- 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-inch.
- E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 1-inch.

- 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.
- 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 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.
- J. Connect electrical devices and components to electrical grounding system. Comply with requirements in the electrical specifications.
- K. 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 the electrical specifications.
- L. Install engraved phenolic nameplate with valve identification on valve.

3.05 CHECKOUT PROCEDURES

- 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. Verify that control valves are installed correctly for flow direction.
 5. Verify that valve body attachment is properly secured and sealed.
 6. Verify that valve actuator and linkage attachment are secure.
 7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 8. Verify that valve ball, disc, and plug travel are unobstructed.
 9. 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.

3.06 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