SECTION 230902 – CONTROL VALVES AND DAMPERS

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(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines")

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 and all other sections of Division 23.

1.2 GENERAL

A. No devices containing mercury will be allowed under this Specification.

1.3 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, Type 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.4 VALVE SELECTION AND SIZING

A. General:

1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.
2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.
4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal HVAC units may be sized based on flow ranges for each pump system.
5. Shut off and two (2) position modulating valves shall be full pipe size.
6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.
7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Minimum pressure and temperature rating of piping systems (complete system of pipe, fittings, joints, etc.) shall be as follows. Where more stringent pressure and temperature ratings are specified under individual product specifications, the more stringent ratings shall be provided. <Edit for Project Requirements>

1.	Chilled Water:	200 psig at 100°F
2.	Process Chilled Water:	200 psig at 100°F
3.	Energy Recovery Water (Glycol):	150 psig at 210°F
4.	Heating Water: .	200 psig at 210°F
5.	Condenser (Tower) Water: .	200 psig at 100°F
6.	Plant Steam: .	Class 300
7.	Humidification Steam:	Class 150
8.	Condensate: .	Class 150

C. Instrumentation Valves:

1. Unless otherwise noted, instrumentation shut-off valves for isolation of control valves, gauges, switches, transmitters, etc., shall be as specified in Division 23, Specification Section “Valves for HVAC Piping System”.

D. Water Valves:

1. Unless otherwise indicated, select modulating control valves to provide 3 psi to 5 psi pressure drop at design flow rate. For additional requirements for terminal unit

control valves see Division 23, Specification Section "Building Automation System – Renovation Projects".

2. Design criteria for sizing modulating valves shall be based on two (2) port, equal percentage valves unless otherwise specified. Select heating and cooling coil control valves of major equipment including air handling units for minimum of 30% to 50% of equipment sub-circuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balancing valve.
3. Select control valves based upon pressure drop calculations and (Cv) values at 90% stroke.
4. Size three (3) way mixing or diverting valves not directly associated with pump sub-circuit for 3 psi to 5 psi pressure drop.
5. Sub-circuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

E. Steam Valves

1. Modulating straight-through globe type valves with linear characteristics for 90% of closing stroke and equal-percentage for final 10%.
2. For steam inlet pressure less than 15 psig, size valves for pressure drop equal to 80% of gauge inlet steam pressure. ($\Delta P = 0.8 \times$ Inlet Gauge Pressure).
3. For steam inlet pressure of 15 psig or greater, size valves for pressure drop equal to 42% of absolute inlet steam pressure. ($\Delta P = 0.42 \times$ Inlet Absolute Pressure).

1.5 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure set points. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two (2) position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

1.6 WARRANTY/GUARENTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: All BAS valves, dampers and accessories shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers of valves, dampers and accessories shall be as follows:

1. Globe Valves: Subject to compliance with requirements, provide globe valves by one (1) of the following:
   a. DeZurik.
   b. Fisher.
   c. Spirax Sarco.

2. Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one (1) of the following:
   a. Bray Valves Inc. (Basis of Design & UMB Preferred)
   b. Milwaukee.

3. Solenoid Valves: Subject to compliance with requirements, provide solenoid valves by one (1) of the following:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

4. Control Dampers: Subject to compliance with requirements, provide control dampers by one (1) of the following:
   a. Ruskin.
   b. Air Balance.
   c. Johnson Controls.
   d. Honeywell.
   e. Greenheck.

5. Actuators for Valves and Dampers: Subject to compliance with requirements, provide actuators by one (1) of the following unless otherwise indicated:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

2.2 HVAC CONTROL VALVES – HYDRONIC AND STEAM SYSTEMS

A. General:
   1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
   2. Use two (2) port or three (3) port globe type control valves with equal percentage contoured throttling plugs for steam and water applications, except as otherwise noted.
   3. Butterfly valves shall be used for water system control valves two and one half (2-1/2) inches and larger provided the valves meet pressure and temperature requirements.

B. Globe Valves (Industrial Grade):
   1. Valves shall be iron or steel body, flanged, Class 150 rating, minimum.
   2. Valves for standard use two (2) inch and smaller shall be unguided, unbalanced equal percentage plug type. Valves two and one half (2-1/2) inches and larger shall be guided plug type with either top and bottom guides or cage restrained plugs. Valves with pressure drops greater than 50% of upstream pressure shall be cage type valves with sound reduction trim.
   3. Valves shall have stainless steel stems, spring-loaded Teflon or Ethylene Propylene (EP) packing, replaceable metal seats and discs. Provide valve trim to limit audible sound levels to 85 dBA or less when measured at five (5) feet.
   4. ANSI Class IV shutoff. Valves shall conform to ANSI B16.10, ISA SP-75.

C. Control Valves - Butterfly Valves (Hydronic Systems):

   1. Control Valves for HVAC Piping Systems Two and One Half (2-1/2) and Larger: All butterfly valves in hydronic piping systems used for control duty shall be bi-directional dead end service general purpose resilient seated butterfly valves with a lugged ductile iron valve body with full threaded lug connections, Nylon – 11 coated ductile iron disk, 416 stainless steel stem, EPDM double seal seats and seals and for actuation type operation. All valves shall be MSS-SP67 face to face dimension. Valve model numbers shall be as listed below:

      Bray - Series 3L with Trim 390* (Basis of Design & UMB Preferred)

      Milwaukee – HL Series*

      *Extensions: where necessary provide shaft extensions to allow mounting of the valve operator outside of pipe insulation.

2. BAS Control Valve Actuators: Actuators shall be DDC Type, 2 way application, "open/closed", "closed/open" or "modulating" control and shall be provided by the valve manufacturer based on the following:

   a. Valve Sizes 2-1/2" to 3": Bray Series 70 Actuators.
   b. Valve Sizes 4" and Larger: Bray Series 71 Actuators

D. Solenoid Valves:
   1. Valves shall be brass or bronze body. Select valves to match required temperatures and pressures, and to have materials that are compatible with intended working fluids.
   2. Line voltage actuators shall be Class "H" (high temperature), listed by UL or CSA.

E. Self-Contained Temperature Regulating Valves:
   1. Valve body shall be 150 psi psi bronze globe type with threaded connections for two (2) inches and smaller and Class 150 steel with flanged connections for two and one half (2-1/2) inches and larger.
   2. Actuators shall be diaphragm type with remote liquid filled bulb with six (6) feet of armored tubing, unless otherwise indicated.
   3. Size valves for maximum bandwidth of 20°F.

2.3 CONTROL DAMPERS

A. General:
   1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
   2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and two (2) position (open/close) dampers shall be parallel blade type.
   3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
   4. AMCA Leakage Classification of Control Dampers

Class	Static Pressure (Inches Water Column)			
	1	4	8	12
	Leakage Rate cfm/ft^2			
IA	3	N/A	N/A	N/A
I	4	8	11	14
II	10	20	28	35
III	40	80	112	140

B. Standard Modulating and Two (2) Position Dampers:
   1. Manufacturers and acceptable model numbers:
      a. Johnson Controls VD-1330 (Double Piece)
      b. Honeywell D2
      c. Ruskin CD50/CD60
      d. Air Balance AC-525/526
      e. Greenheck VCD-43/VDC-60
   2. Damper frames shall be a minimum of 16 gauge galvanized steel or 14 gauge extruded aluminum. Blades shall be a minimum of 16 gauge galvanized steel or 14 gauge aluminum. Blades shall have maximum blade width of eight (8) inches with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
   3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40° to 200°F, pressure differential of six (6) inches WC, and approach velocity of four thousand (4,000) fpm based on four (4) feet damper section width.
   4. Leakage rate shall meet AMCA Leakage Class IA or I.
   5. Testing and ratings shall be per AMCA Standard 500-D.

C. Laboratory and Vivarium Exhaust Fan Shut-off Dampers (Round):
   1. Manufacturers: Swartwout 902 or Ruskin CDR92
   2. Type 316 stainless steel construction, flanged connection, grease lubricated ball bearings, continuous shaft with seal, suitable for maximum temperature 250°F, approach velocity six thousand (6,000) fpm, and differential pressure of thirteen (13) inches WC.
   3. Furnish dampers with neoprene blade seals.
   4. Damper actuators shall be electric 120 V AC, heavy duty industrial quality similar to Valvcon, Rotork, Limitorque or Automax (fail position as indicated).

D. Laboratory and Vivarium Exhaust System Outside Air Bypass Dampers:
   1. Manufacturers: Ruskin Model CD80AF2 or American Warming and Ventilating Model VC-423

2. Galvanized steel construction, suitable for maximum temperature 250°F, approach velocity six thousand (6,000) fpm and differential pressure of thirteen and one half (13.5) inches WC.
3. Air foil blade design, 16 gauge minimum and twelve (12) inches maximum width.
4. Furnish with flexible jamb seals, EPDM, silicone or neoprene blade seals and pneumatic damper actuators with pilot positioners.
5. Damper actuators shall be fail-open, electric 120 V AC, heavy duty industrial quality similar to Valvcon, Rotork, Limitorque or Automax (fail position as indicated).

2.4 SMOKE DAMPERS

A. Refer to Division 23, Specification Section "HVAC Duct Systems and Accessories".

2.5 DAMPER AND VALVE ACTUATORS

A. Pneumatic Diaphragm Valve Actuators with Spring Return:
1. Actuators shall be by same manufacturer as valve body and shall be selected to match maximum diaphragm air pressure, fail position, stroke, shut-off pressure, temperature, torque, etc., required for intended service. Unless otherwise scheduled, diaphragm air pressure shall be sufficient to provide 100% valve shut-off at least equal to pump shut-off head or 125% of rated flow head for water systems, or full rated pressure for steam systems. Select spring ranges to match intended service. If valves or dampers are sequenced, spring ranges shall not overlap.

B. Rolling Diaphragm Pneumatic Damper Actuator with Spring Return:
1. Actuators shall be by same manufacturer as control system or damper manufacturer and shall be selected to match maximum diaphragm air pressure, fail position, stroke, shutoff pressure, temperature, torque, etc., required for intended service.
2. Unless otherwise scheduled, diaphragm air pressure shall be enough to provide 100% damper shutoff at least equal to fan discharge pressure. Select spring ranges to match intended service. If dampers are sequenced, spring ranges shall not overlap.

C. Pneumatic Piston Valve Actuator:
1. Provide dual action piston actuators for large torque applications. Actuators shall be sliding piston type with appropriate linkage and mounting hardware. Provide units suitable for 60 psig to 100 psig compressed air operation, self-draining body, position indicator, and spring return if fail position required. Body shall be aluminum or fiberglass with aluminum piston, BUNA-N or PTFE Piston Seals, and open/close travel stops.

D. Pneumatic Piston Damper Actuator:

1. Provide rack and pinion dual piston actuators with spring return for large torque applications. Actuators shall be sliding piston type with rack and pinion action for quarter turn actuation, provided with appropriate linkage and mounting hardware.
2. Provide units suitable for 60 psig to 100 psig compressed air operation, self-draining body, position indicator, and spring return to fail position as required. Body shall be aluminum or fiberglass with die-cast aluminum piston, carbon steel pinion gear, Nitrile seals, Acetal piston bearings, and open/close travel stops.

E. Pilot Positioners:
1. Pilot positioners for pneumatic actuators shall provide mechanical feedback of actual actuator position. Pilot positioners may use 3 psig to 15 psig pneumatic or 4 to 20 mA electronic input signal with full range 3 psig to 15 psig pneumatic output. Input ranges and gain factors shall be fully field adjustable.

F. Speed Control Valve:
1. Provide speed control valves for "On/Off" actuators to limit speed of actuation to prevent water hammers in liquid systems and reduce stresses on large dampers in air systems.
2. Speed control valves shall allow free flow of control air in one direction and metered flow in other direction. Valve stem locks shall be included to lock adjustment knob in place.
3. Mount speed control valve to exhaust port of solenoid control valve or impulse line from solenoid control valve to actuator, depending upon whether speed control is required for closing or opening of valve or damper.
4. Materials of Construction: Brass bodies with Buna-N, NBR or Nitrile Seals

G. Analog Electronic:
1. Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.
   a. Floating control actuators shall only be used for terminal hot water or chilled water control.
   b. Analog control actuators shall be used for all other modulating applications.
2. Stroke time for major equipment shall be ninety (90) seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than six (6) minutes.
3. Provide spring return feature for fail open or closed positions, as required by control sequence, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.
4. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.

H. Discrete Two (2) Position Electric:

1. Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.

I. Discrete Two (2) Position Heavy-Duty Electric:
1. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.
3. Unless otherwise indicated, actuator power shall be 120 VAC, 60 Hz, 1 Ph.

PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.3 SMOKE DAMPERS

A. Refer to Division 23, Specification Section “HVAC Duct Systems and Accessories”.

3.4 ACTUATORS AND PILOT POSITIONERS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified and shall be provided with spring-return for fail open or fail closed position for fire, freeze, moisture, occupant safety,

equipment protection, heating or cooling system protection on power interruption as indicated and/or as required.

B. Where sequencing of valves or dampers is required for pneumatic systems, such sequencing shall be accomplished by spring ranges adequate for applications to avoid both overlap of operation and simultaneous use of heating and cooling.

C. Provide pilot positioners for pneumatic modulating valves and dampers are proposed for major equipment such as air handling unit coils, heat exchangers, convertors, major water system temperature controls, etc.

D. Provide pilot positioners for pneumatic modulating valve and damper actuators where torque required by controlled devices exceeds 50% of torque capacity of operator.

E. Valve and damper operating speeds shall be selected or adjusted so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

F. Provide speed control valves for "On/Off" actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

G. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

H. Multiple damper sections shall be connected together via jackshaft or other coupling device, not by internal pinned connections at the blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuators shall be mounted directly to the jackshaft or other coupling device for operating damper sections. For instances where the damper actuator cannot be mounted to the jackshaft or other coupling device, damper actuators shall be provided for each damper section.

I. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

END OF SECTION 230902