PART I - GENERAL

1.0 OVERVIEW (Background for AE)

A. Preference for Rotary Control Valves

1. The University is endeavoring, in conjunction with the current trend in the valve industry, to move from the use of sliding stem globe type control valves to the use of rotary valves for HVAC applications.

2. This is not accomplished without challenge given that HVAC grade rotary valves are not available in all sizes and temperature ratings required. Industrial grade rotary valves, on the other hand, are available for every imaginable application in any size desired. However, they are significantly more expensive, especially in smaller sizes. Thus, the University has standardized on the use of HVAC grade rotary valves for most hydronic applications and the use of industrial grade valves for a limited number of applications where HVAC grade valves are deemed inappropriate or inadequate.

3. Steam valves present a special challenge. Since the University utilizes superheated district steam for heating applications in the majority of its buildings, control valves with high temperature ratings are required. HVAC grade rotary valves rated for superheated steam service are not available at the time of this writing, regardless of valve size. Thus, for the sake of economy, the University allows the use of standard HVAC grade globe valves in smaller sizes while requiring the use of industrial grade rotary valves in larger sizes.

B. Rationale: The University’s preference for rotary control valves over sliding stem globe valves is based upon the following rationale:

1. Rotary valves typically have greater rangeability than comparable HVAC grade globe valves, especially in larger sizes. In most cases this allows the use of a single rotary valve in lieu of two globe valves installed in a parallel configuration (see sizing criteria).

2. Rotary valves lend themselves to failing in last position (fail-in-place). This is preferable for many applications on campus, including most heating applications.

3. Given that globe valves have sliding stems, packing wear proves to be a perennial problem requiring on-going maintenance. Rotary valves, on the other hand, have rotating shafts that result in virtually no seal wear. Thus, these valves require very little, if any, maintenance.

4. Rotary valves are especially well suited for use with electric/electronic actuators. The application of rotary electric/electronic actuators to sliding stem globe valves is awkward at best.

5. HVAC grade rotary valves are typically less expensive than HVAC grade globe valves. In large sizes, even industrial grade rotary valves can be less expensive than HVAC grade globe valves.

C. Advantages of Pressure Independent Control Valves

1. At the time of this writing, the University is researching the use of pressure independent (PI) control valves in hydronic systems and is in the process of testing them at multiple locations.

2. The installation of these valves is viewed to be much more beneficial and cost effective when applied to a few large units rather than to numerous small units. This is especially true of large chilled water coils. Their use results in higher and more consistent chilled water “delta T”. This, of course, is beneficial to the larger central chilled water system.
3. Units that provide year-round cooling, such as computer room units, are a particularly good application for pressure independent control valves. In many buildings served by the central chilled water system, the differential pressure control function of the main chilled water control valve at the building service entrance is deactivated in the winter control mode. This often results in elevated and variable differential pressures throughout the building system. Thus, the use of PI control valves at year-round cooling units improves the “controllability” of these units under such conditions. Their use also reduces the potential for valve-generated noise which can become a problem when system differential pressures are elevated. Thus, the University encourages the use of PI valves in such cases although the increased size of each valve must be considered in light of the space available within the cooling unit cabinet. The availability of valves that fully satisfy the specification provided herein may also prove to be a difficulty.

4. Fan coil units and similar equipment, notorious for generating low chilled water delta T, are other applications worthy of consideration for PI valves.

5. A particularly attractive PI valve application is the control of hot water (HW) heating devices (e.g. coils, fin-tube) within a condensing HW generator (boiler) system. This promotes increased HW delta T and resultant reduced HW return temperature.

1.1 RELATED DOCUMENTS
   A. Section 23 09 13.34 – Control Valve Actuators
   B. Exhibit 23 09 13.33-1 – Control Valve/Actuator Worksheet

1.2 CONTROL VALVE APPLICATIONS
   A. Hydronic Systems (i.e. Water-Based Heat Transfer Systems)
      1. All automated valves in hydronic systems shall be rotary type. Modulating control valves shall be either characterized ball or V-notch ball segment type. Modulating control valves in variable flow systems shall be two-way. Two position (on-off) valves shall be either ball or butterfly type. Two valve grades are specified herein, HVAC and industrial. At the chilled water BTU metering / pressure regulating station for each building the modulating control valve in the CHW supply line shall be industrial grade. The automated two position (on-off) valve in the adjacent chilled water return line shall also be industrial grade. [Note to AE: This represents a change from the previous University standard of using a resilient-seated butterfly valve for this application.] The grade of other automated valves shall be HVAC or industrial as scheduled or otherwise indicated within the documents. Except for retrofit applications, HVAC grade valves shall have electronic actuation. Actuators for industrial grade valves shall be electric or pneumatic as scheduled or otherwise indicated.

   B. Steam Systems
      1. Modulating control valves 1 1/2" and smaller in steam systems may be either HVAC globe valves or industrial grade rotary valves with either electronic or pneumatic actuation. Valve grade and actuator type shall be as scheduled or otherwise indicated within the documents. [Note to AE: HVAC grade globe valves (as opposed to rotary valves) are allowed in these smaller sizes only because economical rotary valves with adequate temperature and pressure ratings are not available at the time of this writing. If they become available this specification will be updated.]

      2. Modulating control valves 2" and larger in steam systems shall be industrial grade eccentric plug type with either electric or pneumatic actuation. Actuator type shall be as scheduled or otherwise indicated within the documents.

1.3 CONTROL VALVE SIZING
   A. Two Position (On-Off) Control Valves
      1. Valves shall be sized for minimal fluid/steam pressure drop. Valve connection size shall be equal to pipe size with no reducers.

U OF I FACILITIES STANDARDS 23 09 13.33-2 CONTROL VALVES LAST UPDATED JUNE 15, 2013
B. Modulating Control Valves

[Note to AE: Be mindful that most HVAC systems are substantially over designed and thus, for any given application, the actual maximum flow rate is likely to be substantially less than full design flow rate. This often results in oversized control valves.]

1. Control valves shall be sized to operate at no less than 70% of available stroke at maximum flow rate. [Note to AE: The goal here is to utilize the full available range of the control valve. When control valves are oversized only a portion of their available range (as represented by stroke) is utilized.]

2. At minimum flow rate, control valves shall be sized to operate at or above minimum recommended valve position as determined by manufacturer. [Note to AE: This prevents seat damage resulting from operating the valve too near its closed position.]

[Note to AE: Control valve sizing should be based upon installed Cv rather than rated Cv. Installed Cv takes into account the effect of pipe size reduction. The greater the pipe size reduction at the control valve the greater the reduction in Cv. The use of valve sizing software is required to determine installed Cv. The difference between installed Cv and rated Cv tends to be greater for steam applications, given that pipe size reduction is typically more significant.]

C. Modulating Control Valves for Hydronic Applications

1. Unless otherwise scheduled or indicated within the documents, each control valve shall be sized for a full-open fluid pressure drop at design flow rate that is approximately equal to 50% of the total pressure drop through the branch or dedicated circuit that it controls. The total branch pressure drop equals the sum of the pressure drops through the branch piping, fittings, controlled equipment, control valve, balancing valve, isolation valves and any hydronic specialties (e.g. strainers). This approach yields a valve authority of approximately 0.5. Control valve authority shall be no less than 0.2. [Note to AE: 5 PSI differential is often used as the basis for control valve sizing in hydronic systems. This is based upon the assumption that the pressure differential across each branch circuit will be approximately 10 PSID. In reality the DP will vary throughout any given system. It will be highest near the pump(s) and lowest at the most hydraulically remote location. This must be taken into account when sizing valves, especially those serving central station equipment such as AHUs. This is less of an issue with systems that are somewhat self-balancing such as those with "oversized-main" design or reverse-return configuration. Thus, these system designs are encouraged.]

D. Pressure Independent Control Valves for Hydronic Applications

1. Each cooling unit that requires year-round chilled water service shall be served by a pressure independent control valve. Valve grade and actuator type shall be as scheduled or otherwise indicated within the documents. [Note to AE: This is a recent requirement. See the paragraph entitled "Advantages of Pressure Independent Control Valves" above for rational. Be mindful that the increased size of PI valves must be considered in light of limited space available within cooling unit cabinets.]

E. Modulating Control Valves for Steam Applications

1. For steam supply pressures of 12 PSIG or less, valves shall be sized to yield a gage pressure drop of 100% of the inlet gage pressure at the maximum flow rate, unless otherwise scheduled or indicated within the documents. For steam supply pressures of greater than 12 PSIG, valves shall be sized for a pressure drop of 45% of the inlet absolute pressure at the maximum flow rate, unless otherwise scheduled or indicated within the documents. For HVAC applications, control valves in low pressure steam systems (i.e. with building pressure regulators) shall be sized for a supply steam pressure of 12-15 PSIG unless historical data indicates that this pressure cannot be consistently maintained. In no case shall a control valve serving an HVAC system be sized for a steam inlet pressure less than 10 PSIG. [Note to AE: Sizing for higher supply pressure helps protect against oversizing. Although sizing for 10 PSIG supply
pressure has been common in the past, sizing for 12-15 PSIG helps prevent oversizing.]

2. [Note to AE: Given that virtually all steam-to-hot water heat exchangers (a.k.a. hot water converters) are grossly oversized, control valves for these applications shall be “rounded down” in size rather than increased to a Cv that is substantially greater than that which is required to satisfy the design capacity requirement.]

Oversizing of such heat exchangers creates a great challenge in selecting/sizing steam control valves that will have adequate valve life and performance capabilities for these applications.

If a heat exchanger is known to be intentionally oversized to provide backup capacity for an associated heat recovery system and/or to provide reserve capacity for anticipated future load growth, additional steps must be taken by the designer to ensure proper valve sizing. The installation of multiple parallel valves is one such step.]

3. Control valves shall be sized such that the steam velocity at design conditions does not exceed 0.5 mach for limited periods of time (i.e. several hours). Velocity shall not exceed 0.3 mach for extended periods of time (i.e. days on end).

F. Parallel Valves

1. Sliding stem globe valves
   a. For steam-to-hot water heat exchangers and other high turndown applications a minimum of two control valves shall be provided for each heat transfer device and shall be piped in parallel. In such cases these valves shall be sequenced such that the appropriate sized valve opens first. Sizing of each valve shall be in compliance with the criteria presented above. A common approach to sizing parallel valves is that of selecting one valve for 1/3 of the total system flow rate and another for the remaining 2/3. This rule of thumb approach is discouraged. Rather, an engineered approach shall be used that optimizes valve sizing and sequencing relative to specific minimum and maximum flow conditions within the system. [Note to AE: Optimal valve capacity ratios may be 1/2-1/2, 1/4-3/4, or any other Cv ratio. Similarly, the optimal sequence may result in the larger valve opening prior to the smaller rather than the traditional “small one first” approach.]

2. Rotary valves
   a. Since rotary control valves typically have much higher rangeability than do comparable globe valves it may not be necessary to provide multiple rotary valves. If system turndown does not exceed 10 to 1 a single rotary valve may be used. Turndown ratio is defined as the ratio of maximum design flow rate to minimum design flow rate. [Note to AE: A typical HVAC grade globe valve has an inherent rangeability of 30/1 whereas the inherent rangeability of various industrial grade rotary valves is as follows: eccentric plug 100/1, characterized ball 200/1, ball segment 300/1.]

1.4 ADDITIONAL VALVE SELECTION CRITERIA

A. Valve Characteristic

1. Control valves in CHW and HW applications shall have equal percentage characteristic.

2. Control valves in steam applications shall have linear or equal percentage characteristic.
   a. Equal percentage characteristic preferred for steam pressures \( \leq 12 \) PSIG
   b. Linear characteristic preferred for steam pressures \( > 12 \) PSIG

B. Shut-Off Rating

1. Control valve/actuator assemblies in all hydronic systems shall have shut-off ratings of at least 1.5 times the shut-off head of the system pump(s).
2. Control valve/actuator assemblies in chilled water systems shall have shut-off ratings of 50 PSID minimum.

3. Control valves in all hydronic systems shall have operating differential pressure (dynamic pressure) rating of 50 PSID minimum.

C. Leakage Class
1. Metal-seated valves shall be leakage class IV. Soft-seated control valves shall be leakage class VI unless otherwise specified.

D. Cavitation
1. Control valves shall be selected to meet their intended service without cavitation. If necessary, anti-cavitation trim shall be provided.

E. Noise
1. Control valves shall be selected to meet their intended service without creating objectionable noise.

2. Default maximum sound level shall be 85 dBA. This will likely need to be adjusted based upon location, adjacencies, etc.

3. If necessary, noise attenuating trim shall be provided.

F. Velocity
1. As stated above, steam velocity shall not exceed 0.3 mach although in some cases an absolute maximum velocity of 0.5 mach may be considered.

1.5 FAIL POSITION

A. Heating/cooling applications with rotary actuators (e.g. electric, pneumatic rack and pinion).

Fail in last position (non-spring return):

1. Preheat coils
2. Reheat coils
3. Finned tube units
4. Radiant panel heaters
5. Convector
6. Unit heaters
7. Cabinet unit heats
8. HW fan coil units
9. HW blower coil units
10. ...Steam-to-hot water heat exchangers that serve all devices listed above
11. Fan coil units – heating coil
12. Blower coil units – heating coil
13. CHW coils not exposed to outdoor air
14. Computer room cooling units
15. Other specialty cooling equipment

Fail open (spring return):

1. Chilled water coils potentially exposed to outdoor air
2. Building CHWS pressure regulating / flow control valve at BTU metering station near service entrance
3. Building CHWR isolation valve near service entrance

B. Heating/cooling applications with pneumatic spring-and-diaphragm actuators

Fail open:

1. Preheat coils
2. Finned tube units
3. Radiant panel heaters
4. Convectors
5. Unit heaters
6. Cabinet unit heaters
7. Fan coil units – heating coil
8. Blower coil units – heating coil
9. …Steam-to-hot water heat exchangers that serve all devices listed above
10. Fan coil units – cooling coil
11. Blower coil units – cooling coil
12. CHW coils potentially exposed to outdoor air
13. Building CHWS pressure regulating valve at BTU metering station near service entrance*
14. Building CHWR isolation valve near service entrance*

* Electric actuators that fail in last position are acceptable for valves 6" and larger. Valves of this size require more torque than can be achieved with standard spring-return electric actuators. In such cases control programming shall drive valve open/closed on a scheduled basis to prove proper function of controls via feedback from limit switches and/or position feedback device.

Fail closed:
1. Reheat coils
2. Steam-to-hot water heat exchangers that serve them

C. Safety related applications with spring-return rotary or spring-and-diaphragm actuators.

Fail closed:
1. Domestic water heaters
2. Steam humidifiers
3. Process equipment
4. Other potentially hazardous applications

D. Cooling tower applications
1. Condenser water bypass – Fail closed
2. Cooling tower shut-off (individual cells) – Fail closed
3. Cooling tower makeup – Fail open
4. Cooling tower blow-down – Fail closed
5. Cooling tower winter drains – Fail open

E. Automated check valves for large pumps – Fail open or closed based upon application

[Note to AE: This represents a change from previous standard which was fail closed only.]

Note: For constant flow systems (typically with three-way valves)
Fail open = flow to/through coil/device (no flow through bypass)
Fail closed = no flow to/through coil/device (full flow through bypass)

[Note to AE: The rationale for using “fail in last position” as default for rotary actuated control valves is as follows: The temperature of the area served by the heating/cooling system should be at or near set point when control system failure occurs. Since most HVAC loads change slowly the temperature will drift slowly from set point. An alarm will be registered and communicated via EMS when an excursion is detected (programming is required). In this manner, maintenance staff will be notified that service is needed. In some cases the problem can be corrected before failure is apparent to the end user.
For valves with either type of actuator (rotary or spring-and-diaphragm) the rationale for using “fail open” as the default fail position for CHW cooling coils that are potentially exposed to outdoor air is as follows: The University standard freeze protection system requires that the CHW control valve be opened quickly upon detection of near-freezing temperatures at the coil. Thus, it is essential that this valve fail open to ensure coil protection when a control system failure occurs. In conjunction with this it is essential that the automated building CHW valves at the service entrance also fail open.
1.6 ACTUATORS

A. Valve actuators

1. Refer to Section 23 09 13.34 – Control Valve Actuators for actuator specifications

2. Refer to Control Valve Schedule for application-specific valve/actuator combinations

[Note to AE: See “Exhibit 23 09 13.33-1 Control Valve/Actuator Worksheet” for approved valve/actuator combinations. This worksheet shall be used to prepare detailed control valve schedule(s) for inclusion in project drawings.]

[Note to AE: Provide control valve schedule. This is non-optional. Based upon feedback from contractors it has become clear that given the complexities of these control valve and actuator specifications it is essential that a complete and detailed control valve schedule be provided directly on the project drawings. This schedule shall include all of the following information:

--Valve tag (Each control valve for central station and unitary equipment shall be identified with a unique tag)
--Application (e.g. AHU-xx-PHC, AHU-xx-CHWC, HX-xx, CRAC-xx)
--Media (e.g. steam, chilled water, hot water, hot water/glycol)
--Maximum design capacity/flow rate (e.g. GPM, PPH)
--Minimum design capacity/flow rate (this is essential for determining valve turn-down and will determine if one valve or two in parallel are required)
--Design pressure differential (valve inlet/outlet, needed for actuator sizing)
--Pipe size (needed for calculation of effective Cv)
--Effective Cv (as opposed to published nominal Cv. See discussion on valve sizing above.)
--Pressure drop used for Cv calculation
--Fail position (e.g. spring return fail-open, spring return fail-closed, fail-in-place (aka fail-last-position))
--Positioner (yes/no)
--Valve Identification Number (This clearly identifies the valve type, construction and options in much the same way as a manufacturer’s model number. Example: HYD-HVAC-2W-MOD-CBV-THD-S-1. See Control Valve Worksheet.)
--Actuator Identification Number (Similarly, this identifies the actuator type, construction and options. Example: HVAC-E-R-SR)
--Other pertinent information]

PART 2 - PRODUCTS

Valve Identification Number Breakdown:
[Note to AE - This may seem complex but it is necessary given that there are numerous valve actuator combinations.]

HYD = Hydronic
LPS = Low Pressure Steam
MPS = Medium Pressure Steam
HVAC = HVAC Grade
IND = Industrial Grade
MOD = Modulating
2P = Two Position
PIV = Pressure Independent Valve
2W = Two-way
3W = Three-way
GV = Globe Valve
BV = Ball Valve
CBV = Characterized Ball Valve
BSV = Ball Segment Valve
BFV = Butterfly Valve
HPBF = High Performance Butterfly Valve
ABFV = AWWA Butterfly Valve
EPV = Eccentric Plug Valve
THD = Threaded Connections
FLG = Flanged Connections
LG = Lug Connections
S1 = Size Increment 1
S2 = Size Increment 2
S3 = Size Increment 3
S4 = Size Increment 4

2.1 CONTROL VALVES FOR HYDRONIC APPLICATIONS

A. HVAC GRADE

1. MODULATING, TWO-WAY (HVAC HYDRONIC)

[Note to AE: Globe valves may only be used in sizes 1 ¼” and smaller for pneumatic applications. They are allowed in this small size range rather than characterized ball valves due to unavailability of rotary pneumatic actuators in small sizes.]

a. Globe Valve - (Pneumatic applications only, see Section 23 09 13.34 for actuator specification.)

1) Size 1 ¼” and Smaller, Threaded Globe Valve

HYD-HVAC-MOD-2W-GV-THD-S1

(a) Pressure class 250
(b) 50 PSID shut-off rating
(c) 50 PSI differential pressure rating (dynamic pressure rating)
(d) Leakage class IV
(e) Bronze body
(f) NPT connections
(g) Replaceable stainless steel stems, plugs, and seats
(h) Adjustable or live-loaded packing, renewable in place
(i) Performance characteristic: Equal percentage

b. Characterized Ball Valve (Electronic applications, see Section 23 09 13.34 for actuator specification.)

1) Sizes 1 1/4” and Smaller, Threaded Characterized Ball Valve

--Terminal and unitary equipment

HYD-HVAC-MOD-2W-CBV-THD-S1

(a) 600 PSI cold working pressure
(b) 100 PSI shut-off rating
(c) 50 PSI differential pressure rating (dynamic pressure rating)
(d) 250F temperature rating
(e) Rated for 50% glycol/water solution
(f) Leakage class IV
(g) Forged brass body
(h) NPT connections, sweat connections acceptable only if pre-piped at factory
(i) Stainless steel ball
(j) Stainless steel stem with EPDM 0-ring stem seals
(k) Valve position indicator on top of bare stem
PTFE seats with o-ring backup

Flow characterizing insert disc available in various size/shape openings for specific Cv and performance characteristic

Full port ball without characterizing disc not allowed

Cv of .5 or greater to prevent clogging

Performance characteristic: Equal percentage

Approved manufacturers: Belimo, Griswold, Schneider/TAC, Siemens, Valve Solutions (VSI)

c. V-Notch Ball-Segment Valve (See Section 23 09 13.34 for actuator specification.)

1) Size 1 ½ and 2”, Threaded Ball Segment Valve
   --Small central station units (e.g. AHUs)

   HYD-HVAC-MOD-2W-BSV-THD-S2

   (a) Pressure class 150
   (b) 150 PSID shut-off rating
   (c) 250F temperature rating
   (d) Rated for 50% glycol/water solution
   (e) Leakage class VI, bi-directional
   (f) Carbon steel body
   (g) Flanged connections
   (h) Stainless steel V-notch ball segment
   (i) Reinforced PTFE (RPTFE) seats
   (j) Adjustable shaft packing
   (k) Performance characteristic: Equal percentage
   (l) Approved manufacturers: Valve Solutions (VSI), Belimo, Fisher, Neles/Jamesbury, Samson

2) Size 2 1/2” and Larger, Flanged Ball Segment Valve
   --Larger central station units (e.g. AHUs)

   HYD-HVAC-MOD-2W-BSV-FLG-S3

   (a) Pressure class 150
   (b) 150 PSID shut-off rating
   (c) 250F temperature rating
   (d) Rated for 50% glycol/water solution
   (e) Leakage class VI, bi-directional
   (f) Carbon steel body
   (g) Flanged connections
   (h) Stainless steel V-notch ball segment
   (i) Reinforced PTFE (RPTFE) seats
   (j) Adjustable shaft packing
   (k) Performance characteristic: Equal percentage
   (l) Approved manufacturers: Valve Solutions (VSI), Belimo, Fisher, Neles/Jamesbury, Samson
2. MODULATING, PRESSURE INDEPENDENT, TWO-WAY (HVAC HYDRONIC)
   a. Pressure Independent Characterized Ball Valve (See Section 23 09 13.34 for
      actuator specification.)
      1) Size 2" and Smaller, Threaded Pressure Independent Valve
         HYD-HVAC-MOD-2W-PIV-THD-S1
            (a) Same specification as HYD-HVAC-MOD-2W-CBV-THD-S1 Characterized
                Ball Valve except valve shall also include a pressure compensating
                cartridge that…
                1) compensates for pressure changes in the hydronic system,
                   maintaining constant pressure drop across the flow control portion of
                   the valve assembly.
                2) maintains pressure independent operation up to a system pressure
                   differential of 50 PSID minimum.
                3) imposes a minimum pressure differential no greater than 6.0 PSID
                4) is replaceable without removing valve from piping
            (b) Basis of Design: Belimo PICCV
      2) Size 3" and Larger, Flanged Pressure Independent Valve (See Section 23 09
         13.34 for actuator specification.)
         HYD-HVAC-MOD-2W-PIV-FLG-S2
            (a) 150 PSI cold working pressure
            (b) 100 PSID shut-off rating
            (c) Pressure independent operation up to system pressure differential of 50
                PSID minimum
            (d) Minimum pressure differential no greater than 5.0 PSID
            (e) 220F temperature rating
            (f) Rated for 50% glycol/water solution
            (g) Leakage class IV
            (h) Rangeability: 100 to 1 minimum
            (i) Ductile iron body
            (j) Flanged connections
            (k) Brass, carbon steel, stainless steel, PTFE internal components. Plastic
                components not acceptable
            (l) Seals renewable with valve in place
            (m) Performance characteristic: Equal percentage
            (n) Basis of design: Delta P
   3. MODULATING, THREE-WAY (HVAC HYDRONIC)
      a. Characterized Ball Valve, Three-Way Mixing (See Section 23 09 13.34 for
         actuator specification.)
         1) Size 3" and smaller, Threaded Three-Way Characterized Ball Valve
            HYD-HVAC-MOD-3W-CBV-THD-S1
               (a) 360 PSI cold working pressure
               (b) 40 PSID shut-off rating
(c) 40 PSI differential pressure rating (dynamic pressure rating)
(d) 250F temperature rating
(e) Rated for 50% glycol/water solution
(f) Leakage class IV
(g) Forged brass body
(h) NPT connections, sweat connections acceptable only if pre-piped at factory
(i) Stainless steel ball
(j) Stainless steel blow-out proof stem with EPDM 0-ring stem seals, renewable with valve in place
(k) PTFE seats with o-ring backup
(l) Flow characterizing ports available in various size/shape openings for specific Cv and performance characteristic
(m) Full port ball without characterizing disc not allowed
(n) Cv of 1.0 or greater to prevent clogging
(o) Universal mounting plate
(p) Performance characteristic: Equal percentage
(q) Basis of design: Griswold Unimizer

2) Size 4” and larger, Flanged Three-Way Characterized Ball Valve
HYD-HVAC-MOD-3W-CBV-FLG-S2
(a) 240 PSI cold working pressure
(b) 50 PSID shut-off rating
(c) 50 PSI differential pressure rating (dynamic pressure rating)
(d) 250F temperature rating
(e) Rated for 50% glycol/water solution
(f) Leakage class IV
(g) Cast iron body
(h) Flanged Connections
(i) Stainless steel ball
(j) Stainless steel blow-out proof stem(s) with EPDM 0-ring stem seals
(k) PTFE seats
(l) Flow characterizing parabolic ports, available in various size/shape openings for specific Cv and performance characteristic
(m) Full port ball without characterizing ports not allowed
(n) Universal mounting plate
(o) Performance characteristic: Equal percentage
(p) Basis of design: Griswold Unimizer

4. TWO POSITION (ON-OFF), TWO-WAY (HVAC HYDRONIC)

[Note to AE: Globe valves may only be used in sizes 1 ¼” and smaller for pneumatic applications. They are allowed in this small size range rather than characterized ball valves due to unavailability of rotary pneumatic actuators in small sizes.]
a. Globe Valve - (Pneumatic applications only, see Section 23 09 13.34 for actuator specification.)

1) Size 1 1/4” and Smaller, Threaded Globe Valve

   HYD-HVAC-2P-2W-GV-THD-S1
   (a) Pressure class 250
   (b) 50 PSID shut-off rating
   (c) 50 PSI differential pressure rating (dynamic pressure rating)
   (d) Leakage class IV
   (e) Bronze body
   (f) NPT connections
   (g) Replaceable stainless steel stems, plugs, and seats
   (h) Adjustable or live-loaded packing, renewable in place
   (i) Performance characteristic: Equal percentage

b. Ball Valve (Electronic applications: see section 23 09 13.34 for actuator specification)

1) Sizes 1 1/4” and Smaller, Threaded Ball Valve

   HYD-HVAC-2P-2W-BV-THD-S1
   (a) Same specification as HYD-HVAC-2P-2W-BV-S1 except without flow characterizing disc

2) Size 1 1/2” and 2”, Threaded Two-Piece Full-Port Ball Valve

   HYD-HVAC-2P-2W-BV-FLG-S2
   (a) 600 WOG
   (b) Leakage class VI, bi-directional
   (c) Two-piece cast bronze body. Zinc level in bronze not to exceed 15% (yellow brass not acceptable)
   (d) NPT connections
   (e) ISO mounting pad
   (f) Type 316 stainless steel full-port solid tunneled ball (hollow ball not acceptable)
   (g) Type 316 stainless steel anti-blowout stem and nut
   (h) PTFE seats
   (i) Adjustable stem packing
   (j) Approved manufacturers: Apollo, Milwaukee, Nibco, Watts

3) Size 2 ½” and 3”, Threaded Two-Piece or Three-Piece Standard-Port Ball Valve

   HYD-HVAC-2P-2W-BV-FLG-S3
   (a) 600 WOG
   (b) Leakage class VI, bi-directional
   (c) Two-piece cast bronze body. Zinc level in bronze not to exceed 15% (yellow brass not acceptable)
   (d) NPT or solder connections
c. Butterfly Valve (See section 23 09 13.34 for actuator specification)
   1) Size 2 1/2" through 20", Lug Style Resilient-Seated Butterfly Valve
      HYD-HVAC-2P-2W-BFV-LG-S4
      (a) Bi-directional bubble-tight shut-off rating for in-line service as well as
dead-end service (with either mating flange removed): 200 PSIG for
valves 12” and smaller, 150 PSIG for valves 14” and larger
      (b) Leakage class, bi-directional
      (c) Ductile iron lug style body (cast iron or wafer style body not acceptable)
      (d) EPDM molded-in seat or cartridge style seat with rigid backing ring (boot
type seat not acceptable)
      (e) Aluminum bronze or stainless steel disc
      (f) Type 416 stainless steel shaft

B. INDUSTRIAL GRADE
   1. MODULATING, TWO-WAY (INDUSTRIAL HYDRONIC)
      a. Characterized Ball Valve (See Section 23 09 13.34 for actuator specification.)
         1) Size 2” and Smaller, Threaded Three-Piece Characterized Ball Valve
            HYD-IND-MOD-2W-CBV-THD-S1
            (a) Pressure class 600
            (b) 150 PSID shut-off rating
            (c) 250F temperature rating
            (d) Rated for 50% glycol/water solution
            (e) Leakage class VI, bi-directional
            (f) Carbon steel three-piece body
            (g) NPT connections
            (h) Stainless steel ball
            (i) Reinforced PTFE (RPTFE) seats
            (j) Seat or ball available in various size/shape openings for specific Cv and
performance characteristic
            (k) Performance characteristic: Equal percentage
            (l) Live-loaded stem packing
            (m) Approved manufacturers: Flow-Tek Triad, PBM Series 5, Sharpe Series
V-84, Worcester Series CPT

      b. V-Notch Ball-Segment Valve (See Section 23 09 13.34 for actuator specification.)
         1) Size 2 ½” and Larger, Flanged Ball Segment Valve
HYD-IND-MOD-2W-BSV-FLG-S2

(a) Pressure class 150
(b) 150 PSID shut-off rating
(c) 250F temperature rating
(d) Rated for 50% glycol/water solution
(e) Leakage class VI, bi-directional
(f) Stainless steel or carbon steel body
(g) Flanged connections
(h) Stainless steel V-notch ball segment with hard chrome plating
(i) Reinforced PTFE (RPTFE) seats
(j) Adjustable shaft packing
(k) Performance characteristic: Equal percentage
(l) Approved manufacturers for applications including building CHW control valve at service entrance: Belimo, Fisher, KTM, Neles/Jamesbury, Samson, Valve Solutions (VSI)

[Note to AE: Due to economic considerations, the University has elected (for the time being) to specify more economical ball segment valves for building CHW control at service entrances.]

Further, the University has found that the typical approach employed to size ball segment valves for building CHW control (at service entrances) often results in oversizing. Thus, a specification for eccentric plug valves has been provided below. These valves typically have a Cv approximately half that of a same-size ball segment valve. Eccentric plug valves also offer multiple trim sets for further reducing Cv as desired. Both valves have the same face-to-face dimension. The specific valve type to be provided shall be indicated in the project documents. Selection of valve type and sizing shall be discussed with F&S Engineering prior to completion of documents.]

c. Eccentric Plug Valve (See Section 23 09 13.34 for actuator specification.)

1) Size 2 1/2” and Larger, Flanged Plug Valve

   LPS-MOD-2W-EPV-FLG-S2

   (a) Pressure class 150
   (b) Leakage class IV
   (c) Carbon steel body
   (d) Flanged connections
   (e) 17-4PH or Alloy 6 hardened metal plug
   (f) Stainless steel shaft
   (g) Inconel or Alloy 6 hardened metal seat
   (h) Carbon graphite reinforced TFE seat insert
   (i) Live-loaded stem packing
   (j) Four Cv options per valve
   (k) Capable of easy Cv change via changeout of seat insert.
   (l) Available with noise reduction trim
   (m) Performance characteristic: Linear
2. MODULATING, PRESSURE INDEPENDENT, TWO-WAY (INDUSTRIAL HYDRONIC)
   a. Pressure Independent Characterized Ball Valve (See Section 23 09 13.34 for actuator specification.)

   1) Size 2” and Smaller, Threaded Pressure Independent Valve
      **HYD-IND-MOD-2W-PIV-THD-S1**
      (a) 300 PSI cold working pressure
      (b) 100 PSID shut-off rating
      (c) Pressure independent operation up to system pressure differential of 50 PSID minimum
      (d) Minimum pressure differential no greater than 5.0 PSID
      (e) 220F temperature rating
      (f) Rated for 50% glycol/water solution
      (g) Leakage class IV
      (h) Rangeability: 100 to 1 minimum
      (i) Forged brass body
      (j) NPT connections
      (k) Brass, stainless steel, PTFE internal components. Plastic components not acceptable
      (l) Seals renewable with valve in place
      (m) Performance characteristic: Equal percentage
      (n) Basis of design: Delta P

   2) Size 3” and Larger, Flanged Pressure Independent Valve
      **HYD-IND-MOD-2W-PIV-FLG-S2**
      (a) 150 PSI cold working pressure
      (b) 100 PSID shut-off rating
      (c) Pressure independent operation up to system pressure differential of 50 PSID minimum
      (d) Minimum pressure differential no greater than 5.0 PSID
      (e) 220F temperature rating
      (f) Rated for 50% glycol/water solution
      (g) Leakage class IV
      (h) Rangeability: 100 to 1 minimum
      (i) Ductile iron body
      (j) Flanged connections
      (k) Brass, carbon steel, stainless steel, PTFE internal components. Plastic components not acceptable
      (l) Seals renewable with valve in place
      (m) Performance characteristic: Equal percentage
      (n) Basis of design: Delta P
3. TWO POSITION (ON-OFF), TWO-WAY (INDUSTRIAL HYDRONIC)
   a. Ball Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 2" and Smaller, Threaded Three-Piece Full-Port Ball Valve
         HYD-IND-2P-2W-BV-THD-S1
            (a) Pressure class 600
            (b) 150 PSID shut-off rating
            (c) 250F temperature rating
            (d) Rated for 50% glycol/water solution
            (e) Leakage class VI, bi-directional
            (f) Carbon steel three-piece body
            (g) NPT connections
            (h) Type 316 stainless steel full-port ball and stem
            (i) Reinforced PTFE (RPTFE) seats
            (j) Live-loaded stem packing
            (k) Approved manufacturers: Flow-Tek Triad, Jamesbury Series 4000, KTM Series F180, PBM Series 5, Sharpe Series 84, Worcester Series 44
      2) Size 2 ½" and Larger, Flanged Ball Valve
         HYD-IND-2P-2W-BV-FLG-S2
            (a) Pressure class 150
            (b) 150 PSID shut-off rating
            (c) 250F temperature rating
            (d) Rated for 50% glycol/water solution
            (e) Leakage class VI, bi-directional
            (f) Stainless steel or carbon steel body
            (g) Flanged connections
            (h) Type 316 stainless steel ball and stem
            (i) Reinforced PTFE (RPTFE) seats
            (j) Live-loaded stem packing
            (k) Approved manufacturers: Flow-Tek, PBM, Sharpe, Worcester
      3) Size 3" through 20", Lug Style High Performance Butterfly Valve
         HYD-IND-2P-2W-HPBV-LG-S3
            (a) Pressure class 150
            (b) 150 PSID shut-off rating
            (c) 250F temperature rating
            (d) Rated for 50% glycol/water solution
            (e) Leakage class VI, bi-directional
            (f) Stainless steel, carbon steel or ductile iron lug style body
            (g) Double-offset, stainless steel disc
            (h) Reinforced PTFE (RPTFE) or equivalent seat
(i) Stainless steel shaft
(j) Adjustable shaft packing
(k) Approved manufacturers: Neles/Jamesbury, Cameron W-K-M, Xomox

4) Size 24” and Larger, Resilient-Seated Butterfly Valve (AWWA)
HYD-IND-2P-2W-ABFV-FLG-S4
(a) Meets or exceeds AWWA standard C504
(b) AWWA Class 150B
(c) Bi-directional shut off pressure rating for in-line service: 150 PSIG
(d) Bi-directional shut off pressure rating for dead-end service (with either mating flange removed): 100 PSIG
(e) Leakage class, bi-directional
(f) Cast iron or ductile iron body with flanged end connections
(g) Cast iron or ductile iron offset disc that provides uninterrupted 360 degree seating surface
(h) EPDM resilient seat mechanically attached to allow adjustment/replacement without requiring valve removal or disassembly (seats attached with epoxy are not acceptable)
(i) Stainless steel mating seat ring
(j) Stainless steel shaft
(k) Adjustable shaft packing, replaceable without requiring valve disassembly
(l) Approved manufacturers: Mosser, K-Flo, Pratt

2.2 CONTROL VALVES FOR LOW PRESSURE STEAM APPLICATIONS

A. HVAC OR INDUSTRIAL GRADE

1. MODULATING, TWO-WAY (LP STEAM)
   a. Globe Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 1 1/4” and Smaller, Threaded Globe Valve
         LPS-MOD-2W-GV-THD-S1
         (a) Pressure class 250
         (b) Leakage class IV
         (c) Bronze body
         (d) NPT connections
         (e) Replaceable stainless steel stems, plugs, and seats
         (f) High temperature adjustable or live-loaded packing, renewable in place
         (g) Performance characteristic: Linear preferred, equal percentage acceptable
   b. Eccentric Plug Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 1 1/2” and Larger, Flanged Plug Valve
         LPS-MOD-2W-EPV-FLG-S2
         (a) Pressure class 150
(b) Leakage class IV
(c) Carbon steel body
(d) Flanged connections
(e) 17-4PH or Alloy 6 hardened metal plug
(f) Stainless steel shaft
(g) Inconel or Alloy 6 hardened metal seat
(h) Carbon graphite reinforced TFE seat insert
(i) Live-loaded stem packing
(j) Four Cv options per valve
(k) Capable of easy Cv change via changeout of seat insert.
(l) Available with noise reduction trim
(m) Performance characteristic: Linear
(n) Approved manufacturers: Cashco Ranger, Fisher-Baumann 42000 series, Masonellan Camflex, Warren series 3800

2. TWO-POSITION (ON-OFF), TWO-WAY (LP STEAM)
   --Normal Operation: <15 PSIG, <300F
   --Minimum Rating: 100 PSIG at 337F
   a. Globe Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 1 1/4" and Smaller, Threaded Globe Valve
         LPS-2P-2W-GV-THD-S1
         (a) Pressure class 250
         (b) Leakage class IV
         (c) Bronze body
         (d) NPT connections
         (e) Replaceable stainless steel stems, plugs, and seats
         (f) High temperature adjustable or live-loaded stem packing, renewable in place
   b. Ball Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 1 1/2" and Smaller, Threaded Two-Piece Ball Valve
         LPS-2P-2W-BV-THD-S1
         (a) 1,500 WOG, 150 WSP
         (b) Leakage class VI, bi-directional
         (c) Stainless steel or carbon steel two-piece body
         (d) NPT connections
         (e) ISO mounting pad
         (f) Type 316 stainless steel standard-port or full-port ball and stem
         (g) Ball or cavity vent
         (h) Reinforced PTFE (RPTFE) seats
         (i) Adjustable stem packing
2) Size 2 ½” and Larger, Flanged One-Piece or Two-Piece Ball Valve

LPS-2P-2W-BV-FLG-S2

(a) Pressure class 150
(b) Leakage class VI, bi-directional
(c) Stainless steel or carbon steel one-piece or two-piece body
(d) Flanged connections
(e) ISO mounting pad
(f) Type 316 stainless steel standard-port or full-port ball and stem
(g) Ball or cavity vent
(h) Reinforced PTFE (RPTFE) seats
(i) Adjustable stem packing
(j) Stem extension
(k) Approved manufacturers: Apollo, Flow-Tek, FNW, Jamesbury, Milwaukee, Nibco, Watts

2.3 CONTROL VALVES FOR MEDIUM PRESSURE STEAM APPLICATIONS

--Normal Operation: <60 PSIG, <350F
--Minimum Rating: 200 PSIG, 400F

A. INDUSTRIAL GRADE

2. MODULATING, TWO-WAY (MP STEAM)

a. Eccentric Plug Valve (See Section 23 09 13.34 for actuator specification.)

1) All sizes

MPS-MOD-2W-EPV-FLG-S1

(a) Pressure class 150 or 250
(b) Leakage class IV
(c) Carbon steel body
(d) Flanged connections
(e) 17-4PH or Alloy 6 hardened metal plug
(f) Stainless steel shaft
(g) Inconel or Alloy 6 hardened metal seat
(h) Carbon graphite reinforced TFE seat insert
(i) Live-loaded stem packing
(j) Capable of easy Cv change via seat insert change
(k) Available with noise reduction trim
(l) Performance characteristic: Linear
(m) Approved manufacturers: Cashco Ranger, Fisher-Baumann 42000 series, Masoneilan Camflex, Warren series 3800

3. TWO-POSITION (ON-OFF), TWO-WAY (MP STEAM)
   a. Ball Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 2” and Smaller, Threaded Three-Piece Full-Port Ball Valve
         MPS-2P-2W-BV-THD-S1
         (a) Pressure class 600
         (b) Leakage class VI, bi-directional
         (c) Carbon steel three-piece body
         (d) NPT connections
         (e) Type 316 stainless steel full-port ball and stem
         (f) Ball or cavity vent
         (g) Carbon-graphite reinforced TFM seats
         (h) Adjustable graphite stem packing
         (i) Approved manufacturers: Jamesbury Series 4000, KTM Series F180, PBM Series 5, Worcester Series 44
      2) Size 2 ½” and Larger, Flanged One-Piece or Two-Piece Ball Valve
         MPS-2P-2W-BV-FLG-S2
         (a) Pressure class 150
         (b) Leakage class VI, bi-directional
         (c) Stainless steel or carbon steel one-piece or two-piece body
         (d) Flanged connections
         (e) Ball or cavity vent
         (f) Type 316 stainless steel standard-port or full-port ball and stem
         (g) Carbon-graphite reinforced TFM seats
         (h) Adjustable graphite stem packing
         (i) Geared rotary hand-wheel operator
         (j) Approved manufacturers: Jamesbury, KTM, PBM, Worcester
   b. High Performance Butterfly Valve (See Section 23 09 13.34 for actuator specification.)
      1) Size 2 ½” and Larger
         MPS-2P-2W-HPBV-LG-S2
(a) Pressure class 150  
(b) Leakage class VI, bi-directional  
(c) Stainless steel or carbon steel lug-style body  
(d) Type 316 stainless steel disc and shaft  
(e) Carbon-graphite reinforced TFM seat preferred, TFM seat acceptable  
(f) Adjustable graphite shaft packing  
(g) Geared rotary hand-wheel operator  
(h) Approved manufacturers: Neles/Jamesbury, Cameron W-K-M, Xomox

2.4 FLANGE GASKETS
A. Steam Applications
1. Rated for working pressure and temperature of system.  
2. High pressure/medium pressure steam systems up to and including connection to PRV.  
   a. Spiral wound type.  
   b. Stainless steel with flexible graphite filler material.  
   c. Basis of design: Flexitallic Flexicarb (gray stripe).  
3. Low pressure steam system downstream of PRV.  
   a. Compressed fiber type.  
   b. Basis of design: Flexitallic SF2401.

PART 3 - EXECUTION
3.1 CRITICAL APPLICATIONS
A. Manual Bypass Valve
   1. If equipment or device served by a control valve is deemed to be critical service with inadequate backup, a manual throttling valve shall be provided in bypass arrangement such that control valve may be removed/replaced without interruption of service. Bypass valve shall be sized for 2/3 design capacity of equipment served.  
   [Note to AE: When a HW heating system is served by a single heat exchanger without backup, a manual bypass valve shall always be provided. When a redundant heat exchanger is provided, bypass valves are not required.]

3.2 INSTALLATION
A. Accessibility
   1. Control valves shall be located for ease of access to valve and actuator for service and removal/replacement.  
B. Unions/Flanges
   1. Pipe union shall be provided on each side of each control valve to facilitate removal and replacement.  
C. Strainers
   1. Line-size strainer shall be provided in piping system upstream of each control valve.

3.3 ORIENTATION
   [Note to AE: Control valve orientation requirements are often violated by installing contractors, typically due to lack of training. It is common for valves to be installed in the vertically upward position with the actuator located directly above the valve. This often results in premature]
Actuator failure due to overheating. Electric actuators are particularly vulnerable in this regard. Appropriate steps shall be taken to ensure that this does not occur.

A. Rotary Control Valves

1. For hydronic applications, preferred valve orientation is with shaft oriented horizontally. Valve shall not be installed such that shaft is oriented vertically downward (i.e. with actuator at bottom). Exception: Small rotary valves with electronic actuators (e.g. at reheat coils and fan coil units) may be installed in any orientation.

2. For steam applications, valves/actuators shall be installed such that shaft is oriented horizontally. In no case shall valve be oriented in vertically upward position. Vertical upward orientation results in overheating of actuator and accessories.

3. Valve shall be installed such that the preferred direction of flow as indicated within product literature matches the actual direction of fluid flow through the valve.

B. Sliding stem (e.g. globe) control valves

1. For hydronic applications, valve shall be installed such that the stem is oriented within 45 degrees of the vertical upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall valve be installed such that stem is oriented vertically downward.

2. For steam applications, valve shall be installed such that stem is not oriented in the vertically upward position to prevent overheating of actuator and accessories. Preferred orientation is 45 degrees from vertically upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall the valve be installed such that stem is oriented vertically downward.

3. Valve shall be installed such that direction of flow indication on valve body and/or product literature matches actual direction of fluid flow through valve.

3.4 INSULATION

A. Insulated Piping Applications

1. Control valves in insulated piping systems shall have bodies, flanges, etc. completely insulated. This applies to valves in heating systems (i.e. steam and hot water) as well as those in cooling systems. Practice of leaving heating valves and associated unions/flanges un-insulated is not acceptable. Steam valves shall be insulated such that actuator and accessories are protected from excessive convective and radiated heat.

2. Insulated valves shall be equipped with extended stems and protective shields as required to allow operation without disturbing insulation.

3.5 FLANGE GASKETS

A. Steam Applications

1. Provide flange gaskets rated for design working pressure and temperature of system.

2. Provide antiseize compound on flange bolt threads.

3.6 CONTROL VALVE ACTUATOR SCHEDULE

[Note to AE: As stated below, see “Exhibit 23 09 13.33-1 Control Valve/Actuator Worksheet” for approved valve/actuator combinations. This worksheet shall be used to prepare detailed control valve schedule(s) for inclusion in project drawings.]

[WORKSHEETS IN EXHIBIT 23 09 13.33-1 ARE SHOWN BELOW]
## Hydronic - HVAC Grade

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<th>ID #</th>
<th>Application / Type</th>
<th>Size</th>
<th>Valve Type</th>
<th>ID #</th>
<th>Positioner</th>
<th>Electric</th>
<th>ID #</th>
<th>Positioner</th>
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<tbody>
<tr>
<td>HYD-HVAC-MOD-2W-GY-THD-S1</td>
<td>Hydronic - Modulating</td>
<td>≤ 1 1/4&quot;</td>
<td>Globe - Thd</td>
<td>HVAC-LP-LTN-ID15-SV</td>
<td>Per Sched</td>
<td>Electronic</td>
<td>HVAC-E-R-SR or FIP</td>
<td>No</td>
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<tr>
<td>HYD-HVAC-MOD-2W-CBV-THD-S1</td>
<td>Hydronic - Modulating</td>
<td>≤ 1 1/4&quot;</td>
<td>Characterized Ball - Thd</td>
<td>HVAC-LP-LTN-ID15-SV</td>
<td>Per Sched</td>
<td>Electronic</td>
<td>HVAC-E-R-SR or FIP</td>
<td>Yes</td>
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<tr>
<td>HYD-HVAC-MOD-2W-BSV-THD-S2</td>
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<td>Ball Segment - Thd</td>
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<td>Per Sched</td>
<td>Ball Segment - Thd</td>
<td>HVAC-E-R-SR or FIP</td>
<td>Yes</td>
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<td>HYD-HVAC-MOD-2W-BX4FLG-S3</td>
<td>Hydronic - Modulating</td>
<td>≥ 2 1/2&quot;</td>
<td>Ball Segment - Fig</td>
<td>HVAC-LP-R-ID15-S</td>
<td>Per Sched</td>
<td>Ball Segment - Fig</td>
<td>HVAC-E-R-SR or FIP</td>
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<td>HYD-HVAC-MOD-2W-PV-THD-S1</td>
<td>Hydronic - PI-Modulating</td>
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<td>PI Rotary - Thd</td>
<td>HVAC-E-R-SR or FIP</td>
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<tr>
<td>HYD-HVAC-MOD-2W-PV-FLG-S2</td>
<td>Hydronic - PI-Modulating</td>
<td>≤ 3&quot;</td>
<td>PI Rotary - Fig</td>
<td>HVAC-LP-R-ID15-S</td>
<td>Per Sched</td>
<td>PI Rotary - Fig</td>
<td>HVAC-E-R-SR or FIP</td>
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<td>HYD-HVAC-MOD-2W-DBX-THD-S1</td>
<td>Hydronic - 3 Way</td>
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<td>Characterized Ball - Thd</td>
<td>HVAC-E-R-SR or FIP</td>
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<td>HYD-HVAC-MOD-3W-CBV-FLG-S2</td>
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## Hydronic, Industrial Grade

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<th>Application / Type</th>
<th>Size</th>
<th>Valve Type</th>
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<th>Positioner</th>
<th>Electric</th>
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<th>Positioner</th>
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<td>HYD-IND-MOD-2W-CBV-THD-S1</td>
<td>Hydronic - Modulating</td>
<td>≤ 2&quot;</td>
<td>Characterized Ball - 3 Pcs - Thd</td>
<td>IND-HPR-RS-ID15-D-K1</td>
<td>Yes</td>
<td>Characterized Ball - Thd</td>
<td>IND-E-R-SR or FIP</td>
<td>Yes</td>
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<td>HYD-IND-MOD-2W-BSV-FLG-S2</td>
<td>Hydronic - Modulating</td>
<td>≥ 2 1/2&quot;</td>
<td>Ball Segment - Fig</td>
<td>IND-HPR-RS-ID15-D-K1</td>
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<td>Ball Segment - Fig</td>
<td>IND-E-R-SR or FIP</td>
<td>Yes</td>
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<tr>
<td>HYD-IND-MOD-2W-PRY-THD-S1</td>
<td>Hydronic - PI-Modulating</td>
<td>≤ 2&quot;</td>
<td>PI Rotary - Thd</td>
<td>IND-HPR-RS-ID15-D-K1</td>
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<td>PI Rotary - Thd</td>
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<tr>
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<td>≥ 3&quot;</td>
<td>PI Rotary - Fig</td>
<td>IND-HPR-RS-ID15-D-K1</td>
<td>Yes</td>
<td>PI Rotary - Fig</td>
<td>IND-E-R-SR or FIP</td>
<td>Yes</td>
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<tr>
<td>HYD-IND-2P-2W-EV-THD-S1</td>
<td>Hydronic - 2 Pcs (On/Off)</td>
<td>≤ 2&quot;</td>
<td>FP Ball - 3 Pcs - Thd</td>
<td>IND-HPR-RS-ID15-D-K1</td>
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<td>FP Ball - 3 Pcs - Thd</td>
<td>IND-E-R-SR or FIP</td>
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<td>HYD-IND-2P-2W-FLG-S2</td>
<td>Hydronic - 2 Pcs (On/Off)</td>
<td>≥ 2 1/2&quot;</td>
<td>Ball - Fig</td>
<td>IND-HPR-RS-ID15-D-K1</td>
<td>No</td>
<td>Ball - Fig</td>
<td>IND-E-R-SR or FIP</td>
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<td>Hydronic - 2 Pcs (On/Off)</td>
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<td>AWWA Butterfly - Fig</td>
<td>IND-HPR-RS-ID15-D-K1</td>
<td>No</td>
<td>AWWA Butterfly - Fig</td>
<td>IND-E-R-SR or FIP</td>
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## Control Valve / Actuator Worksheet

**Low Pressure Steam - HVAC Grade or Industrial Grade**

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<th>Valve</th>
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<th>Application / Type</th>
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<tbody>
<tr>
<td>USP-MOD-2W-EPV-FLG-02</td>
<td>LP Steam - Modulating</td>
<td>≥ 2&quot;</td>
<td>Eccentric Plug - Fig</td>
<td>IND-UP-R-SD-MOD</td>
<td>Per Sched</td>
<td>Eccentric Plug - Fig</td>
<td>IND-E-R-SR or FP</td>
<td>Yes</td>
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<tr>
<td>LPS-MOD-2W-GV-THD-S1</td>
<td>LP Steam - 2 Pos (On/Off)</td>
<td>≤ 2&quot;</td>
<td>Globe - Thd</td>
<td>HVAC-UP-LIN-SD-GV</td>
<td>No</td>
<td></td>
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</tr>
<tr>
<td>LPS-MOD-2W-GV-THD-S1</td>
<td>LP Steam - 2 Pos (On/Off)</td>
<td>≤ 2&quot;</td>
<td>Globe - Thd</td>
<td>HVAC-UP-LIN-SD-GV</td>
<td>No</td>
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<tr>
<td>LPS-MOD-2W-BV-FLG-S2</td>
<td>LP Steam - 2 Pos (On/Off)</td>
<td>≥ 2 1/2&quot;</td>
<td>SP or FF Ball - Thd</td>
<td>HVAC-UP-LIN-ED-MP</td>
<td>No</td>
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<tr>
<td>LPS-MOD-2W-HPBY-LG-S3</td>
<td>LP Steam - 2 Pos (On/Off)</td>
<td>≥ 2 1/2&quot;</td>
<td>HP Butterfly - Lug</td>
<td>HVAC-UP-LIN-ED-MP</td>
<td>No</td>
<td></td>
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</tbody>
</table>

**Medium Pressure Steam - Industrial Grade**

<table>
<thead>
<tr>
<th>Valve</th>
<th>ID #</th>
<th>Application / Type</th>
<th>ID #</th>
<th>Pneumatic</th>
<th>ID #</th>
<th>Positioner</th>
<th>Electric</th>
<th>ID #</th>
<th>Positioner</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPS-MOD-2W-EPV-FLG-S1</td>
<td>MP Steam - Modulating</td>
<td>All sizes</td>
<td>Eccentric Plug - Fig</td>
<td>IND-HP-R-SR-MOD or IND-HP-R-DA-MOD or IND-UP-R-SD-MOD</td>
<td>Per Sched</td>
<td>Eccentric Plug - Fig</td>
<td>IND-E-R-SR or FP</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>MPS-2P-2W-BV-THD-S1</td>
<td>MP Steam - 2 Pos (On/Off)</td>
<td>≤ 2&quot;</td>
<td>Ball - 3 Pc - Thd</td>
<td>IND-HP-R-SR-TF or IND-HP-R-DA-TF</td>
<td>No</td>
<td>Ball - 3 Pc - Thd</td>
<td>IND-E-R-SR or FP</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>MPS-2P-2W-BV-FLG-S2</td>
<td>MP Steam - 2 Pos (On/Off)</td>
<td>≥ 2 1/2&quot;</td>
<td>Ball - 1 or 2 Pc - Fig</td>
<td>IND-HP-R-SR-TF or IND-HP-R-DA-TF</td>
<td>No</td>
<td>Ball - 1 or 2 Pc - Fig</td>
<td>IND-E-R-SR or FP</td>
<td>No</td>
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<tr>
<td>MPS-2P-2W-HPBY-LG-S2</td>
<td>MP Steam - 2 Pos (On/Off)</td>
<td>≥ 2 1/2&quot;</td>
<td>HP Butterfly - Lug</td>
<td>IND-HP-R-SR-TF or IND-HP-R-DA-TF</td>
<td>No</td>
<td>HP Butterfly - Lug</td>
<td>IND-E-R-SR or FP</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

_END OF SECTION 23 09 13.33_

This section of the *U of I Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.