SECTION 23 20 16 - STEAM AND CONDENSATE SPECIALTIES

PART I - GENERAL

1.1 SECTION INCLUDES

A. Strainers

B. Steam Traps

C. Vacuum Breakers

D. Pressure Regulating Valves

E. Safety Relief Valves

[Note to PSC: Although treated within F&S as components of Division 33 – Utilities steam systems, PRVs and condensate pump units are specified within Division 23 – HVAC steam systems given that they are physically located within buildings.]

1.2 RELATED SECTIONS

A. *Section 23 23 13 – Steam and Condensate Piping*

B. *Section 33 63 23 – Tunnel Steam and Condensate System*s

1. Specifications for utility (tunnel) steam system components are provided in *Division 33 - Utilities* as referenced herein. *Section 23 20 16* applies to building steam and condensate specialties only.

C. *Section 23 09 13 – Instrumentation and Control Devices for HVAC. [Note to PSC: The requirements for flow meters for steam condensate systems are listed in Section 23 09 13. Insert flow meter requirements into appropriate CSI section for inclusion in Project Specifications.]*

D. *Section 23 07 19 – HVAC Piping Insulation*

1.3 REFERENCES

A. *ASME B31.9 – Building Services Piping*

B. *ASME Boiler and Pressure Vessel Code*

C. *Applicable ASME Standards*

D. *Illinois Steel Products Procurement Act*

E. *International Mechanical Code*

1.4 QUALITY ASSURANCE

A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph entitled *REFERENCES*.

B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.5 SUBMITTALS

A. Strainers: Type, materials of construction, temperature/pressure rating, strainer screen mesh size.

B. Steam traps: Type, design, materials of construction, temperature/pressure rating, parameters, size/capacity. Trap schedule including all traps shall be submitted.

C. Vacuum breakers: Type, materials of construction, temperature/pressure rating, capacity.

D. Pressure regulating valves: Type, design, materials of construction, temperature/pressure rating, pressure setting, capacity.

E. Safety relief valves: Type, design, materials of construction, temperature/pressure rating, size, capacity.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Materials and equipment shall be protected from physical damage and weather during transport.

B. Materials and equipment shall be stored indoors protected from physical damage and exposure to dust and debris.

C. Materials and equipment shall be protected from physical damage and exposure to dust and debris during construction...

1.7 WARRANTY

A. Products shall be warranted by manufacturer to be free from defects in material and workmanship for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Manufacturer shall repair or replace failed item at no cost to Owner.

B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joints shall be repaired or replaced at no cost to Owner.

PART 2 – PRODUCTS

Note: Specifications for utility (tunnel) pipe, fittings, valves are provided in *Division 33 – Utilities*

2.1 Y-PATTERN PIPELINE STRAINERS

A. High Pressure Steam and Condensate $\leq$ 150 PSIG (175 PSIG worst case)

1. Size 2” and Smaller, Threaded Cast Iron
    a. Pressure class 250
    b. Cast iron body
    c. NPT connections
    d. Threaded blow-off connection
    e. 20 mesh stainless steel screen
2. Size 2” and Smaller, Threaded Cast Steel
    a. Pressure class 300
    b. Cast carbon steel body
    c. NPT connections
    d. Threaded blow-off connection
    e. 20 mesh stainless steel screen
3. Size 2 ½” and Larger, Flanged Cast Steel
    a. Pressure class 300
    b. Cast carbon steel body
    c. Flanged connections
    d. Threaded blow-off connection
    e. Size 2 ½” through 4”: 1/16” perforated stainless steel screen
    f. Size 6” and larger: 1/8” perforated stainless steel screen

B. Medium Pressure Steam and Condensate ≤ 60 PSIG (125 PSIG worst case)
   1. Size 2" and Smaller, Threaded Cast Iron
      a. Pressure class 250
      b. Cast iron body
      c. NPT connections
      d. Threaded blow-off connection
      e. 20 mesh stainless steel screen
   2. Size 2 ½" and Larger, Flanged Cast Iron
      a. Pressure class 250
      b. Cast iron body
      c. Flanged connections
      d. Threaded blow-off connection
      e. Size 2 ½" through 4": 1/16" perforated stainless steel screen
      f. Size 6" and larger: 1/8" perforated stainless steel screen
   3. Size 2½" and Larger, Flanged Cast Steel
      a. Pressure class 150
      b. Cast carbon steel body
      c. Flanged connections
      d. Threaded blow-off connection
      e. Size 2 ½" through 4": 1/16" perforated stainless steel screen
      f. Size 6" and larger: 1/8" perforated stainless steel screen

C. Low Pressure Steam and Condensate ≤ 15 PSIG (25 PSIG worst case)
   1. Size 2" and Smaller, Threaded Cast Iron
      a. Pressure class 125
      b. Cast iron body
      c. NPT connections
      d. Threaded blow-off connection
      e. 20 mesh stainless steel screen
   2. Size 2 ½" and Larger, Flanged Cast Iron
      a. Pressure class 125
      b. Cast iron body
      c. Flanged connections
      d. Threaded blow-off connection
      e. Size 2 ½" through 4": 1/16" perforated stainless steel screen
      f. Size 6" and larger: 1/8" perforated stainless steel screen
   3. Size 2½" and Larger, Flanged Cast Steel
      a. Pressure class 150
      b. Cast steel body

c. Flanged connections

d. Threaded blow-off connection

e. Size 2 ½" through 4": 1/16" perforated stainless steel screen

f. Size 6" and larger: 1/8" perforated stainless steel screen

2.2 STEAM TRAPS

A. Rating

1. Trap body and internals shall be rated for minimum of 1.5 times system design operating pressure or relief valve pressure setting, whichever is greater. Trap shall be rated for simultaneous temperature listed.

a. High pressure system $\leq$ 400F

1) 1.5 x 150 PSIG = 225 PSIG

2) Relief valve setting = 175 PSIG

b. Medium pressure "Campus Steam" system (building with no PRV) $\leq$ 350F

1) 1.5 x 60 PSIG = 90 PSIG

2) Relief valve setting = 125 PSIG

c. Low pressure system (building with PRV) $\leq$ 300F

1) 1.5 x 15 = 22.5 PSIG

2) Relief valve setting = 25 PSIG

B. Inverted Bucket

1. Body: cast iron
2. Cover: removable, bolted
3. Internals, including valve and seat: Replaceable, stainless steel
4. Connections: NPT
5. Approved manufacturers:

a. Armstrong

b. Sarco

c. Mepco

C. Float and Thermostatic

1. Body: Cast iron
2. Cover plate: removable, bolted
3. Internals, including valve and seat: Replaceable, stainless steel
4. Connections: NPT
5. Approved manufacturers

a. Armstrong

b. Sarco

c. Mepco

D. Thermostatic (Radiator)

1. Body: bronze or brass
2. Cover: removable, threaded

3. Valve and seat: replaceable, stainless steel
4. Diaphragm: replaceable phosphor bronze or stainless steel
5. Connections: NPT with integral union
6. Approved manufacturers
    a. Watts (Illinois Engineering)
    b. Mepco
    c. Barnes and Jones
7. Approved options
    a. Same as other existing traps within building if predominant
    b. Direct replacement of existing traps to avoid unnecessary pipe modifications

E. Thermodynamic
1. Body: stainless steel
2. Cover: removable, threaded
3. Disc and seat: replaceable, stainless steel
4. Connections: NPT
5. Approved manufacturers
    a. Armstrong
    b. Sarco
    c. Mepco

F. Sizing
1. Traps shall be sized with warm-up safety factor as recommended by manufacturer for application.

2.3 VACUUM BREAKERS

A. All stainless steel construction
B. ½" or ¾" NPT connection
C. Rated 300 PSIG, 400F
D. 10 SCFM (minimum) at 0.5" Hg (maximum)
E. Approved Manufacturer/Product
1. Armstrong VB21, ½" NPT connection, 10 SCFM airflow rate at 0.35" Hg cracking pressure

2.4 STEAM PRESSURE REGULATING VALVES

[Note to PSC: Discuss project inlet design pressure with Owner. Inlet pressures are impacted by season and location on campus. Do not oversize PRVs by sizing based upon maximum winter load at minimum summer pressure. Size based upon winter load at winter inlet pressure and/or summer load at summer inlet pressure.]

[Note to PSC: Discuss Option # for project with Owner. Edit spec as appropriate.]

A. Medium Pressure Steam (Campus Steam) – Option #1: Direct Acting PRV (Boylston)

Typical Application: Building Heating Service

- Normal Operation: 20-40 PSIG Inlet, 5-10 PSIG outlet, ≤350F

1. Size 2" and smaller

a. Self-contained, direct acting, spring-loaded, diaphragm type (non-piloted)
b. Failure position, open
c. Dead-end service, leakage class 4
d. Bronze body
e. NPT connections
f. Pressure class 250
g. Stainless Steel, plug and shaft
h. Exposed springs for easy adjustment
i. Spring range as appropriate for application
j. Minimum pressure differential: 5 PSID
k. Minimum outlet pressure:
1) Perimeter heating (radiation) applications: 3 PSIG
2) Coil and heat exchanger applications: 5 PSIG
3) Other: Per system requirement
l. Maximum temperature: 400 degrees F
m. Basis of design: Boylston Fig. 90

2. Size 2 ½" and larger
a. Direct acting, spring-loaded, diaphragm type (non-piloted)
b. Failure position, open
c. Dead-end service, leakage class 4
d. Semi-steel body
e. Pressure class 125
f. Flanged connections
g. Single seat design, easily renewable
h. Stainless steel plug, seat and shaft
i. Exposed springs for easy adjustment
j. Spring range as appropriate for application
k. 3-ply composition diaphragm
1) Perimeter heating (radiation) applications: 3 PSIG
2) Coil and heat exchanger applications: 5 PSIG
3) Other: Per system requirements
l. Maximum temperature: 400 degrees F
m. Basis of design: Boylston Fig. 390

B. Medium Pressure Steam (Campus Steam) – Option #2 - Externally Piloted PRV (e.g. Spence)

Typical Application: Building Heating Service

- Normal Operation: 20-40 PSIG Inlet, 5-10 PSIG, $\leq$ 350F

1. Size 2" and smaller
a. Externally piloted, diaphragm or bellows operated

b. Pressure class 250 – cast or ductile iron body
c. Pressure class 300 – cast carbon steel body
d. NPT connections
e. Replaceable hardened stainless steel plugs and seats
f. Replaceable stainless steel diaphragm/bellows and hardware
g. Spring range as appropriate for application
h. Accuracy: 10% of set point over full range of operation
i. Approved manufacturers
    1) Spence
    2) Cashco
    3) Fisher

2. Size 2 ½" and Larger
a. Externally piloted, diaphragm or bellows operated
b. Pressure class 250 – cast or ductile iron body
c. Pressure class 300 – cast carbon steel body
d. Flanged connections
e. Replaceable hardened stainless steel plugs and seats
f. Replaceable stainless steel diaphragm/bellows and hardware
g. Spring range as appropriate for application
h. Accuracy: 10% of set point over full range of operation
i. Approved manufacturers
    1) Spence
    2) Cashco
    3) Fisher

C. High Pressure Steam – Externally Piloted PRV

Typical Application: Building Heating Service

- Normal Operation: 150 PSIG Inlet, 60 PSIG outlet or 60 PSIG inlet, 10 PSIG outlet, ≤400F

1. Size 2" and smaller
a. Externally piloted, diaphragm or bellows operated
b. Pressure class 250 – cast or ductile iron body
c. Pressure class 300 – cast carbon steel body
d. NPT connections
e. Replaceable hardened stainless steel plugs and seats
f. Replaceable stainless steel diaphragm/bellows and hardware
g. Spring range as appropriate for application
h. Accuracy: 10% of set point over full range of operation
i. Approved manufacturers
    1) Spence

2) Cashco
3) Fisher

2. Size 2 ½" and Larger
   a. Externally piloted, diaphragm or bellows operated
   b. Pressure class 250 – cast or ductile iron body
   c. Pressure class 300 – cast carbon steel body
   d. Flanged connections
   e. Replaceable hardened stainless steel plugs and seats
   f. Replaceable stainless steel diaphragm/bellows and hardware
   g. Spring range as appropriate for application
   h. Accuracy: 10% of set point over full range of operation
   i. Approved manufacturers
      1) Spence
      2) Cashco
      3) Fisher

D. High Pressure Steam – Internally Piloted PRV

Typical Application: Process Equipment, Kitchen Equipment

- Normal Operation: 150 PSIG Inlet, 60 PSIG outlet ≤400F

1. Size 2" and smaller
   a. Internally piloted, piston operated
   b. Pressure class 250 – cast or ductile iron body
   c. Pressure class 300 – cast carbon steel body
   d. NPT connections
   e. Replaceable hardened stainless steel plugs and seats
   f. Replaceable stainless steel piston and hardware
   g. Accuracy: 10% of set point over full range of operation
   h. Approved manufacturers
      1) Spence
      2) Cashco
      3) Fisher

E. Medium Pressure Steam – Internally Piloted PRV

Typical Application: Domestic Water Heater, Humidifier

- Normal Operation: 20-40 PSIG Inlet, 5-10 PSIG outlet ≤350F

1. Size 2" and smaller
   a. Internally piloted, piston operated
   b. Pressure class 125 – cast or ductile iron body
   c. Pressure class 150 – cast carbon steel body
   d. NPT connections

e. Replaceable hardened stainless steel plugs and seats

f. Replaceable stainless steel piston and hardware

g. Accuracy: 10% of set point over full range of operation

h. Approved manufacturers: Spence, Cashco, Fisher

2.5 SAFETY RELIEF VALVES

A. Size 2" and smaller

1. ASME Section I and VIII certified and labeled
2. Pressure class 250
3. Bronze or cast iron body with side outlet
4. NPT connections
5. Stainless steel trim
6. Lift lever
7. Basis of design
   a. Kunkle Model 6030
8. Other approved manufacturers
   a. Consolidated
   b. Keckley

B. Size 2 ½" and larger

1. ASME Section I and VIII certified and labeled
2. Pressure class 250
3. Cast iron body
4. Side outlet
5. Flanged connections
6. Stainless steel trim
7. Bolted bonnet
8. Lift lever
9. Basis of design
   a. Kunkle Model 6252
10. Other approved manufacturers
    a. Consolidated
    b. Keckley

A. Relief valve pressure setting shall be as indicated on drawings or in schedule. Pressure setting shall be as required to provide adequate protection for all piping, devices, equipment and components in steam system.

B. Safety relief valve sizing shall be in compliance with applicable sections of ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 STRAINERS

A. Y-Pattern Pipeline Strainers

1. Strainer blowdown connection shall be fitted with drain valve nipple and cap. Drain valve shall be full port ball valve per specifications for service. See section *23 - 22 -13 Steam and Condensate Piping* for valve specifications.
2. Strainer shall be installed in horizontal piping or in vertical piping with downward flow.
3. Strainer located in horizontal line shall be installed with basket in horizontal plane to prevent condensate build-up in basket.
4. Strainer shall be provided in steam system upstream of each control valve and at other locations indicated on drawings.
5. Strainer shall be provided in condensate system upstream of each trap and at other locations indicated on drawings.
6. Pipe union shall be provided downstream of each strainer with threaded connections to facilitate removal.

3.2 STEAM TRAPS

A. Steam trap shall be provided at outlet of each steam utilizing device or piece of equipment to provide full condensate drainage. Trap shall be located for ease of access to facilitate service and removal/replacement.

B. Steam trap shall be provided at each low point and at end-of-main in steam system to prevent collection of condensate in piping and maintain a dry steam system.

C. Traps serving equipment with modulating control valves shall be F&T type to provide continuous condensate removal and venting of large volumes of air. F&T traps shall be piped for full gravity drainage without vertical lift.

D. Traps for drip applications shall be inverted bucket type for robustness and fail-open function. Drip traps may be piped with vertical lift within pressure differential limitations.

E. Traps for on-off applications may be inverted bucket or thermodynamic type. On-off traps may be piped with vertical lift within pressure differential limitations.

F. Drip leg with scale pocket shall be provided for each trap. Drip leg shall be extended and trap positioned such that trap inlet is no less than 14" below bottom of steam pipe or device outlet. Where potential for superheated steam exists, trap inlet shall be no less than 28" below steam pipe.

G. Strainer shall be provided at each trap inlet.

H. Test valve and swing check valve shall be provided at each trap outlet. Pipe unions shall be provided at trap inlet and outlet to facilitate removal.

I. Exceptions for thermostatic traps serving radiators, fin tube and similar applications <u>where space constraints dictate</u>:

1. Drip leg may be reduced.
2. Strainer may be deleted.
3. Test valve and/or check valve may be deleted.

J. Trap Application Table:

Application	Trap Type	Notes
HW converter	F&T	
Air coil	F&T	
Domestic water heater	F&T	

Low point drip, end-of-main drip	Inverted bucket	
Radiator, convector, fin tube	Thermostatic	Reduced drip leg allowed
HP process equipment	Thermodynamic	e.g. Lab sterilizer, cage washer
Superheated steam applications	Thermodynamic	

K. Drip Leg Sizing Table:

Main Size	Drip Leg Size, Minimum
4" and smaller	Full main size
6"	4"
8" and larger	½ main size

3.3 VACUUM BREAKERS

A. Vacuum breakers shall be installed in vertical upright position.

B. Steam coil applications

1. Vacuum breaker shall be provided at coil outlet. Elevation shall be at or above coil outlet. Vacuum breaker shall not be located at steam trap elevation.

C. Heat exchanger applications

1. Vacuum breaker shall be provided at shell connection provided by manufacturer for such purpose. If no such connection exists vacuum breakers shall be provided as indicated above for steam coil.

D. Additionally, vacuum breakers shall be provided at all other locations indicated on drawings.

3.4 PRESSURE REGULATING VALVES

A. Self-Contained PRV

1. Accessibility

a. Pressure regulating valve shall be located for ease of access to facilitate service and removal/replacement.

2. Piping

a. Lengths of straight pipe shall be provided upstream and downstream of regulator in compliance with manufacturer's recommendation. Straight piping shall be no less than 10 diameters upstream and 20 diameters of regulator.

b. Properly sized pipe reducer shall be provided at valve inlet and outlet.

3. Strainer

a. Line-size strainer and eccentric reducer shall be provided in piping system upstream of regulator.

4. Isolation Valves

a. Isolation valves shall be provided to allow isolation of strainer and regulator from system.

5. Unions/Flanges

a. Pipe union or flanges shall be provided on each side of regulating valve to facilitate removal and replacement.

6. Pilot Line

a. Pilot/control line shall be provided for each direct acting or externally piloted regulator in conformance with Manufacture's IOM. Pilot shall be connected to steam main no nearer than 10 pipe diameters downstream of regulator.

b. Pilot/control line shall be pitched away from regulator.

c. Throttling valve shall be provided in pilot/control line.

7. Orientation

a. Regulating valve shall be installed in horizontal piping.

b. Regulating valve shall be oriented as recommended by Manufacturer..

8. Accumulator

a. "Condensate accumulator" (e.g. Boylston #300) shall be provided as indicated in manufacturer's installation instructions. Applies to Boylston direct-acting regulating valves only.

[Note to PSC: Installation of an accumulator appears to be unique to Boylston regulators. Its primary purpose is to protect the diaphragm from direct exposure to live steam. Perhaps it has a secondary purpose? The Boylston manual includes the following text. Its logic is not clearly understood by this author.

"The No. 300 condensate accumulator embodies no moving parts and consequently acts entirely by the action of the steam. The pumping action of the rubber diaphragm will naturally displace the condensate in the diaphragm chamber at times. This will cause a slight variation of reduced pressure. With the accumulator installed, the water held in the vertical pipe connection will never vary more than one or two inches due to the water merely flowing from one chamber to another."]

9. Adjustment

a. Regulator shall be adjusted for system pressures according to manufacturer's IOM.

10. Sound Attenuation

a. Sound attenuating valve trim and/or external covering shall be provided as required to maintain acceptable noise level. Unless specified or scheduled otherwise sound level shall not exceed 85 db A. *[Not to PSC: Standard insulation typically provides approximately 10 db A of attenuation.]*

3.5 SAFETY RELIEF VALVES

A. Relief valve shall be provided at every location in steam system where, in any circumstance, over-pressure protection could occur.

B. Relief valve shall be located for ease of access to facilitate operation of trip handle, adjustment and removal/replacement.

C. Relief valve shall be installed in vertically upward configuration with horizontal discharge.

D. Relief valve vent piping shall be provided. Vent piping shall be extended and terminated in safe manner with consideration of hazard to maintenance personnel as well as general public. Vent piping shall be insulated as required to eliminate burn hazard. Vent piping shall be terminated with vertical discharge 7 ft. minimum above roof unless clearly indicated otherwise in drawings.

E. Vent piping shall be configured as required to minimize physical force on valve body at all operating temperatures.

F. Drip pan elbow shall be provided unless specifically indicated otherwise in drawings. Drain piping shall be extended full size from drip pan elbow to floor drain. With approval of PSC, flexible metal hose may be used to provide necessary flexibility if installation precludes use of drip pan elbow.

G. Vent piping shall be continuously pitched backward toward relief valve. If drip pan elbow is not provided, drain leg shall be provided at base of vent piping to collect water and prevent collection at relief valve outlet. ¾" drain piping shall be extended from drain leg to floor drain and turned downward to discharge directly into drain.

3.6 FLOW METERS

A. Flow Meters for Steam Condensate.

1. Installation of magnetic flow meters for steam condensate applications shall comply with requirements listed in *Section 23 09 13 - Instrumentation and Control Devices for HVAC*.

3.7 INSULATION

A. Steam and condensate specialties shall be insulated in compliance with Section *23 05 16 – HVAC Equipment Insulation.*

END OF SECTION 23 20 16

This section of the *U of I Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.