PART I - GENERAL

1.1 SECTION INCLUDES

[Note to PSC: This specification combines piping, specialties, supports and hangers within a single section given that tunnel steam systems are a very specific (narrow) application.]

A. Steam and Condensate Piping
   1. Pipe and Fittings
   2. Valves
B. Steam and Condensate Specialties
   1. Strainers
   2. Steam Traps
   3. Flexible Metal Hose
   4. Expansion Joints
C. Hangers and Supports
   1. Supports
   2. Anchors
   3. Guides

1.2 RELATED SECTIONS

A. Section 23 22 13 - Steam and Condensate Piping
B. Section 23 20 00 – Pipe Joining
C. Section 23 22 16 – Steam and Condensate Specialties
D. Section 23 09 13 – Instrumentation and Control Devices for HVAC
E. Section 23 07 19 – HVAC Pipe Insulation
F. Drawing 23 22 00-01 – Flow Diagram – Steam Heating System
G. Drawing 23 22 00-02 – Flow Diagram – Steam PRV and Condensate Return System

1.3 REFERENCES

A. ASME B31.1 – Power Piping
B. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture
C. MSS SP-69 - Pipe Hangers and Supports – Selection and Application
D. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices
E. Applicable ASME B16 Standards for valves and fittings
F. International Mechanical Code
G. Illinois Steel Products Procurement Act

1.4 QUALITY ASSURANCE

A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph 1.3 REFERENCES above.
B. Installation, start-up and operation shall be in compliance with Manufacturer’s recommendations and IOM.
1.5 PIPE CERTIFICATION
   A. Certification is required for all pipe and fittings within scope of ASME B31.1. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

1.6 SUBMITTALS
   A. Pipe and tubing: Type, material, ASTM number, schedule/wall thickness, pipe certification
   B. Fittings: Type, material, pressure class, ASTM number
   C. Unions: Type, material, pressure class, ASTM number
   D. Flanges: Type, material, pressure class, ASTM number
   E. Flange gaskets: Type, design, materials of construction, temperature/pressure rating
   F. Valves: Type, pressure class, leakage class, pressure/temperature rating, materials of construction, construction details
   G. Steam traps: Type, materials of construction, pressure/temperature rating, parameters/sizing. Trap schedule, including all traps shall be submitted.
      [Note to PSC: Provide trap schedule on drawings.]
   H. Flexible metal hose: Type, design, materials of construction, temperature/pressure ratings, length
   I. Expansion Joints: Type, design, materials of construction, temperature/pressure ratings, travel distance. [Note to PSC: PSC shall be prepared to submit design calculations to Owner.]
   J. Pipe Supports, Anchors, Guides: Type, design, materials construction. [Note to PSC: PSC shall be prepared to submit design calculations to Owner.]
   K. Coatings: Manufacturer’s specifications, MSDS and application instructions.
   L. Contractor’s installation shop drawings for expansion joints
   M. Contractor’s installation shop drawings for supports, anchors and guides
   N. Pipe certifications
   O. Welder certifications
   P. Weld records
   Q. Leak test report
   R. Visual and radiographic test reports as applicable

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING
   A. Pipe and tubing shall be transported with ends tightly covered.
   B. Fittings, valves, specialties and materials shall be transported protected from physical damage and protected from weather.
   C. All materials shall be stored indoors protected from physical damage and exposure to fluids, dust and debris.
   D. Large pipe may be stored outdoors on rack or wood blocking with ends tightly covered.

1.8 WARRANTY
   A. Products and installation thereof shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service. Defective product or installation shall be repaired or replaced at no cost to Owner.

1.9 SYSTEM DESCRIPTION
   A. High Pressure Steam System
1. Operating Conditions:
   a. Normal: ≤165 PSIG, ≤400F
   b. Worst Case: 175 PSIG, 450F (plant relief valve setting)

2. System Includes:
   a. High pressure distribution piping and valves within tunnel
   b. First steam valve inside building
   c. Associated warm-up, blowdown/drain, condensate, pumped condensate piping and valves
   d. Steam trap isolation valve, strainer
   e. Steam traps
   f. Flexible metal hose
   g. Expansion joints

B. Medium Pressure “Campus Steam” System

1. Operating Conditions:
   a. Normal Operation: ≤60 PSIG, ≤350F
   b. Worst Case: 125 PSIG, 450F (plant relief valve setting)

2. System Includes:
   a. Medium pressure distribution piping and valves within tunnel
   b. First steam valve inside building
   c. Associated warm-up, blowdown/drain, condensate piping and valves
   d. Steam trap isolation valve and strainer
   e. Steam traps
   f. Flexible metal hose
   g. Expansion joints

C. Condensate Return (Trap Discharge) Piping

1. Operating Conditions:
   a. Normal: <15 PSIG, <250F
   b. Worst case: 125 PSIG, 450F

2. System Includes:
   a. Condensate piping and valves
   b. Trap isolation valve at trap outlet

D. Pumped Condensate System

1. Operating Conditions:
   a. Normal: ≤60 PSIG, ≤212F
   b. Worst Case: Same

2. System Includes:
   a. Pumped condensate piping and valves within tunnel
   b. First pumped condensate valve inside building
PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS  (See system description above)

A. High Pressure System
   1. 2” and Smaller, Socket Weld
      a. Pipe: Carbon Steel, ASTM A106 Grade B Seamless, Schedule 40
      b. Fittings: Forged Steel, ASTM A105, Class 3000, Socket Weld
   2. 2 ½” and Larger, Butt Weld
      a. Pipe: Carbon Steel, ASTM A106 Grade B Seamless, Schedule Standard

B. Medium Pressure ‘Campus Steam’ System
   1. 2” and Smaller, Socket Weld
      a. Pipe: Carbon Steel, ASTM A106 Grade B Seamless, Schedule Standard
      b. Fittings: Forged Steel, ASTM A105, Class 3000, Socket Weld
   2. 2 ½” and Larger, Butt Weld
      a. Pipe: Carbon Steel, ASTM A106 Grade B Seamless, Schedule Standard

C. Blowdown/Drain, Warmup (High Pressure, Medium Pressure)
   1. 2” and Smaller, Socket Weld
      a. Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80
      b. Fittings: Forged Steel, ASTM A105, Class 3000, Socket Weld
   2. 2” and Smaller, Threaded
      a. Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80
      b. Fittings: ASTM A105, Class 3000, NPT

D. Condensate Return (Trap Discharge) System
   1. 2” and Smaller, Threaded
      a. Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80
      b. Fittings: Cast Iron or malleable Iron, Class 250, NPT
      c. Unions: Cast iron or malleable Iron, Class 250, NPT

E. Pumped Condensate System
   1. 2” and Smaller, Socket Weld
      a. Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80
      b. Fittings: Forged Steel, ASTM A105, Class 3000, Socket Weld
   2. 2 ½” and Larger, Flanged
      a. Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80
      c. Flanges: Forged Steel, Class 150, ASTM A105, ASME/ANSI B16.5, Weld Neck
2.2 JOINING MATERIALS

A. Welded Joints
   1. Materials per Weld Procedure Specifications (WPS)

B. Flanged Joints
   1. Gaskets, All Steam Pressures
      1) Spiral wound type
      2) Stainless steel with flexible graphite filler material
      3) Basis of design: Flexitallic Flexicarb (gray stripe)

   [Note to PSC: The University has found non-asbestos compressed fiber type gaskets to be inadequate for utility steam service at any pressure. Spiral wound gaskets are required for all flanged steam valve or piping connections.]

   2. Bolts
      a. Hexagonal: ASME B18.2.1
      b. Temperatures less than 400F
         1) Carbon steel, ASTM A307 Grade B
      c. Temperatures 400F – 790F
         2) Alloy steel, ASTM A193 Grade B7

   3. Nuts
      a. Hexagonal: ASME B18.2.2
      b. Temperatures less than 400F
         1) Carbon steel, ASTM A194 Grade B
      c. Temperatures 400F – 790F
         2) Carbon Steel, ASTM A194 Grade 2H

C. Threaded Joints
   1. Thread Sealant
      a. Paste type, non-hardening, rated for temperature

2.3 SHUT-OFF VALVES

Notes:

1. Steam and condensate valves within Utility (tunnel) system shall have welded connections unless indicated otherwise.
   1. Exceptions: Threaded sacrificial blow-down valves (lower valve in two-valve assembly), strainers, steam traps and flexible metal hose shall have threaded connections. In some cases globe valves may also have welded connections.

2. First steam valve inside building including associated warm-up, blowdown and trap isolation valves are components of the utility system rather than the building system even though technically located within the building.
   1. Thus “first valves” shall be utility grade welded valves. Division 33 specifications shall apply to these valves.

A. Shut-Off Valves for High Pressure System
   1. Size 2” and Smaller, Socket-Weld Forged Steel Wedge Gate Valve
      a. ANSI class 800
b. Shut-off class IV, bi-directional

c. Forged carbon steel body

d. Socket-welding connections

e. Bolted bonnet

f. Outside screw and yoke, rising stem design

g. 13% chrome steel wedge

h. Alloy 6 (Stellite) hard-faced seats

i. Renewable seat rings

j. Integral back seat for positive packing chamber isolation

k. Stainless steel gasket with graphite filler

l. Graphite stem packing

m. Spoked hand wheel

n. Approved manufacturers
   1) Bonney Forge
   2) Hancock
   3) Smith

2. Size 2” and Smaller, Threaded Forged Steel Wedge Gate Valve
   – Sacrificial Blowdown Valve
   a. Same as Socket-Weld Gate Valve only with NPT connections in lieu of socket-weld connections.

3. Size 2 ½ and 3”, Butt-Weld Cast Steel Wedge Gate Valve
   a. ANSI class 300
   b. Shut-off class IV, bi-directional
   c. Cast carbon steel body
   d. Butt-welding connections
   e. Outside screw and yoke, rising stem design
   f. 13% chrome steel flexible wedge
   g. Alloy 6 (Stellite) hard-faced seats
   h. Seal-welded seat rings
   i. Integral back seat for positive packing chamber isolation
   j. Stainless steel gasket with graphite filler
   k. Graphite stem packing
   l. Spoked hand wheel

m. Approved manufacturers
   1) Kitz
   2) Velan

4. Size 4” and Larger, Butt-Weld Triple or Quadruple Offset Butterfly Valve
   a. ANSI class 300
   b. API 598 zero leakage shutoff rating, bi-directional
c. Carbon steel body
d. Butt-welding connections to match pipe schedule
e. Carbon steel “floating disk” (i.e. disk not pinned or rigidly attached to shaft)
f. 316 stainless steel disk rings and body seat
g. “Torque seated” rather than flexible-seal design
h. Adjustable graphite shaft packing
i. Geared rotary hand-wheel operator sized for maximum rim pull of 100 lb.
j. Approved Manufacturers
   1) Zwick Series Tri-Con
   2) Quadax
   3) Xomox Series 9000
   4) FlowSeal MS

B. Shut-Off Valves for Medium Pressure ‘Campus Steam’ System
   – Note: Valves and flanges for Medium Pressure steam were previously specified Class 150. These have been upgraded to Class 300.

1. Size 2” and Smaller, Socket-Weld Forged Steel Wedge Gate Valve
   a. ANSI class 800
   b. Shut-off class IV, bi-directional
   c. Forged carbon steel body
   d. Socket-welding connections
   e. Bolted bonnet
   f. Outside screw and yoke, rising stem design
   g. 13% chrome steel wedge
   h. Alloy 6 (Stellite) hard-faced seats
   i. Renewable seat rings
   j. Integral back seat for positive packing chamber isolation
   k. Stainless steel gasket with graphite filler
   l. Graphite stem packing
   m. Spoked hand wheel
   n. Approved manufacturers
      1) Bonney Forge
      2) Hancock
      3) Smith

2. Size 2” and Smaller, Threaded Forged Steel Wedge Gate Valve
   – Sacrificial Blowdown Valve
      a. Same as Socket-Weld Gate Valve only with NPT connections in lieu of socket-weld connections.

3. Size 2 ½ and 3”, Butt-Weld Cast Steel Wedge Gate Valve
   a. ANSI class 300
b. Shut-off class IV, bi-directional

c. Cast carbon steel body

d. Butt-welding connections

e. Outside screw and yoke, rising stem design

f. 13% chrome steel flexible wedge

g. Alloy 6 (Stellite) hard-faced seats

h. Seal-welded seat rings

i. Integral back seat for positive packing chamber isolation

j. Stainless steel gasket with graphite filler

k. Graphite stem packing

l. Spoked hand wheel

m. Approved manufacturers
   1) Kitz
   2) Velan

4. Size 4” and Larger, Butt-Weld Triple or Quadruple Offset Butterfly Valve

   a. ANSI class 300
   
   b. API 598 zero leakage shutoff rating, bi-directional
   
   c. Carbon steel body
   
   d. Butt-welding connections to match pipe schedule
   
   e. Carbon steel “floating disk” (i.e. disk not pinned or rigidly attached to shaft)
   
   f. 316 stainless steel disk rings and body seat
   
   g. “Torque seated” rather than flexible-seal design
   
   h. Adjustable graphite shaft packing
   
   i. Geared rotary hand-wheel operator sized for maximum rim pull of 100 lb.

   j. Approved manufacturers
      1) Zwick Series Tri-Con
      2) Quadax
      3) Xomox Series 9000
      4) FlowSeal MS

C. Shut-Off Valves for Condensate Piping
   – Downstream of Steam Trap (Trap Discharge)

1. Size 2” and Smaller, Socket-Weld Forged Steel Wedge Gate Valve

   a. ANSI class 800
   
   b. Shut-off class IV, bi-directional
   
   c. Forged carbon steel body
   
   d. Socket-welding connections
   
   e. Bolted bonnet
   
   f. Outside screw and yoke, rising stem design
g. 13% chrome steel wedge  
h. Alloy 6 (Stellite) hard-faced seats  
i. Renewable seat rings  
j. Integral back seat for positive packing chamber isolation  
k. Stainless steel gasket with graphite filler  
l. Graphite stem packing  
m. Spoked hand wheel  
n. Approved manufacturers  
   1) Bonney Forge  
   2) Hancock  
   3) Smith  

2. Size 2 ½ and 3", Flanged or Butt-Weld Cast Steel Wedge Gate Valve  
   – Typically for replacement of existing  
   a. ANSI class 150  
   b. Shut-off class IV, bi-directional  
   c. Cast carbon steel body  
   d. Flanged or butt-welding connections  
   e. Outside screw and yoke, rising stem design  
   f. 13% chrome steel flexible wedge  
   g. Alloy 6 (Stellite) hard-faced seats  
   h. Seal-welded seat rings  
   i. Integral back seat for positive packing chamber isolation  
   j. Stainless steel gasket with graphite filler  
   k. Graphite stem packing  
   l. Spoked hand wheel  
   m. Approved manufacturers  
      1) Kitz  
      2) Velan  

3. Size 2 ½" and Larger, Lug-Style High Performance Butterfly Valve  
   a. ANSI class 150  
   b. Shut-off class VI, bi-directional  
   c. Stainless steel or carbon steel lug-style body  
   d. 316 stainless steel double-offset disc  
   e. Reinforced TFM seats  
   f. Disc spacers to center disc in seat  
   g. PH-4 stainless steel shaft  
   h. Stainless steel backed polymer shaft bearings  
   i. Adjustable graphite shaft packing
j. Geared rotary hand-wheel operator

k. Approved manufacturers
   1) Jamesbury
   2) Xomox
   3) Cameron W-K-M

D. Shut-Off Valves for Condensate Piping
   – Downstream of Steam Trap (Trap Discharge)
   **CONTRACTOR’S OPTION: Ball valves in lieu of gate valves**

1. Size 2” and Smaller, Socket-Weld Three-Piece Full-Port Ball Valve
   a. ANSI class 600
   b. Shut-off class VI, bi-directional
   c. Carbon steel three-piece body
   d. Socket-welding connections
   e. 316 stainless steel full-port ball and stem
   f. Vented ball
   g. Reinforced TFM seats
   h. Live-loaded graphite stem packing
   i. Extended stem to clear insulation
   j. Latch-lock handle
   k. Approved manufacturers
      1) Jamesbury
      2) Habonim
      3) PBM
      4) Worcester

2. Size 2 ½” and Larger, Butt-Weld Three-Piece Ball Valve
   a. ANSI class 600
   b. Shut-off class VI, bi-directional
   c. Carbon steel three-piece body
   d. Extended butt-welding connections to match pipe schedule
   e. 316 stainless steel ball and stem
   f. Vented ball
   g. Reinforced TFM seats
   h. Live-loaded graphite stem packing
   i. Extended stem to clear insulation
   j. Geared rotary hand-wheel operator or latch-lock handle
   k. Approved manufacturers
      1) Jamesbury
      2) Habonim
E. Shut-Off Valves for Pumped Condensate System

1. Size 2” and Smaller, Socket-Weld Forged Steel Wedge Gate Valve
   a. ANSI class 800
   b. Shut-off class IV, bi-directional
   c. Forged carbon steel body
   d. Socket-welding connections
   e. Bolted bonnet
   f. Outside screw and yoke, rising stem design
   g. 13% chrome steel wedge
   h. Alloy 6 (Stellite) hard-faced seats
   i. Renewable seat rings
   j. Integral back seat for positive packing chamber isolation
   k. Stainless steel gasket with graphite filler
   l. Graphite stem packing
   m. Spoked hand wheel
   n. Approved manufacturers
      1) Bonnie Forge
      2) Hancock
      3) Smith

2. Size 2 ½ and 3”, Flanged or Butt-Weld Cast Steel Wedge Gate Valve
   a. ANSI class 150
   b. Shut-off class IV, bi-directional
   c. Cast carbon steel body
   d. Flanged or butt-welding connections
   e. Outside screw and yoke, rising stem design
   f. 13% chrome steel flexible wedge
   g. Alloy 6 (Stellite) hard-faced seats
   h. Seal-welded seat rings
   i. Integral back seat for positive packing chamber isolation
   j. Stainless steel gasket with graphite filler
   k. Graphite stem packing
   l. Spoked hand wheel
   m. Approved manufacturers
      1) Kitz
      2) Velan

3. Size 2 ½” and Larger, Lug-Style High Performance Butterfly Valve
a. ANSI class 150
b. Shut-off class VI, bi-directional
c. Stainless steel or carbon steel lug-style body
d. 316 stainless steel double-offset disc
e. Reinforced TFM seats
f. Disc spacers to center disc in seat
g. PH-4 stainless steel shaft
h. Stainless steel backed polymer shaft bearings
i. Adjustable graphite shaft packing
j. Geared rotary hand-wheel operator
k. Approved manufacturers
   1) Jamesbury
   2) Xomox
   3) Cameron W-K-M

F. Shut-Off Valves for Pumped Condensate

CONTRACTOR’S OPTION: Ball valves in lieu of gate valves

1. Size 2” and Smaller, Socket-Weld Three-Piece Full-Port Ball Valve
   a. ANSI class 600
   b. Shut-off class VI, bi-directional
c. Carbon steel three-piece body
d. Socket-welding connections
e. 316 stainless steel full-port ball and stem
f. Vented ball
g. Reinforced TFM seats
h. Live-loaded graphite stem packing
i. Extended stem to clear insulation
j. Latch-lock handle
k. Approved manufacturers
   1) Jamesbury
   2) Habonim
   3) PBM
   4) Worcester

2. Size 2 1/2” and Larger, Flanged Ball Valve
   a. ANSI class 150
   b. Shut-off class VI, bi-directional
c. Carbon steel body
d. Flanged connections
e. 316 stainless steel ball and stem
f. Vented ball
g. Reinforced TFM seats
h. Adjustable graphite stem packing
i. Extended stem to clear insulation
j. Geared rotary hand-wheel operator or latch-lock handle
k. Approved manufacturers
   1) Jamesbury
   2) Habonim
   3) PBM
   4) Worcester

2.4 GLOBE VALVES

A. High Pressure and Medium Pressure Steam Systems
   1. Size 2" and Smaller, Socket-Weld Forged Steel Globe Valve
      a. ANSI Class 800
      b. Forged carbon steel body
      c. Socket-welding connections
      d. Bolted bonnet
      e. Outside screw and yoke, rising stem design
      f. 13% chrome steel loose solid disc
      g. Alloy 6 (Stellite) hard-faced seat
      h. Renewable seat rings
      i. Integral back seat for positive packing chamber isolation
      j. Stainless steel gasket with graphite filler
      k. Graphite stem packing
      l. Spoked hand wheel
      m. Approved manufacturers
         1) Bonney Forge
         2) Hancock
         3) Smith

   2. Size 2" and Smaller, Threaded Forged Steel Globe Valve
      a. Same as Socket-Weld Globe Valve only with NPT connections in lieu of socket-weld connections.

2.5 WYE STRAINERS

A. High Pressure and Medium Pressure Steam and Condensate
   1. Size 2" and Smaller, Threaded Cast Iron
      a. Pressure class 250
      b. Cast iron body
      c. NPT connections
      d. Threaded blow-off connection
2.6 STEAM TRAPS

A. High Pressure and Medium Pressure Steam and Condensate

[Note to PSC: Armstrong is the only approved manufacturer of inverted bucket traps for utility steam applications. Armstrong inverted bucket traps are clearly superior to other manufacturers of IB traps, including Sarco. Sarco’s forte is float and thermostatic traps.]

1. Inverted Bucket Steam Trap
   a. Body: Cast iron
   b. Rated 250 PSIG @ 450F
   c. Cover: Removable, bolted
   d. Internals: Stainless steel
   e. Valve and seat: Hardened chrome steel, 17-4PH
   f. Connections: NPT
   g. Approved manufacturer/model:
      1) Horizontal installation: Armstrong 800-813 Series
      2) Vertical installation: Armstrong 211-216 Series
   h. Trap Size
      1) Traps shall typically have ¾” connections.
      2) Traps shall be sized with warm-up safety factor as recommended by manufacturer and confirmed by Owner.

2.7 FLEXIBLE METAL HOSE

A. High Pressure and Medium Pressure Steam and Condensate

1. Stainless Steel Braided Hose
   a. 2” and Smaller
      1) Rated 300 PSIG at 600F
      2) Stainless steel inner bellows
      3) Stainless steel external braided cover
4) Welded braid capture
   (a) Ferrule type braid capture not allowed

5) NPT connections

b. Basis of Design: US Hose Corporation, Model USBX
   1) Other Approved Manufacturers
      (i) Metraflex “Superflex”
      (ii) Hyspan / Universal Metal Hose
      (iii) Engineered Flexible Products

2.8 EXPANSION JOINTS

   A. High Pressure and Medium Pressure Steam and Condensate
      1. Packed Slip-Type Joint, Single or Double Slip
         a. Pressure class
            1) Class 300 - High pressure system
            2) Class 300 – Medium pressure “Campus Steam” system
         b. Body
            1) Carbon steel
            2) Integral carbon steel base
            3) Weld end connections
         c. Slip(s)
            1) Carbon steel
            2) Machined and chrome plated
            3) Weld end connection(s)
            4) Integral limit stop(s)
         d. Slip Guides
            1) Nonmetallic
            2) Internal and external
         e. Packing cylinders
            1) Custom-located on body for project-specific access
            2) Packable under full line pressure
         f. Packing
            1) Semi-plastic self-lubricating injectable graphite
         g. Basis of Design (preferred):
            1) Advanced Thermal Systems (ATS) Type TP2
         h. Also approved:
            1) Adsco RJ Ram-Pak
            2) Hyspan Series 6500

2.9 PIPE SUPPORTS

   A. Pipe supports shall be fabricated steel structures designed for anchoring to floor, wall or
      combination of floor and ceiling of walkable tunnels and vaults. Supports within shallow
tunnels shall be wall supported to prevent contact with water at floor level. If floor supports are required concrete pedestals shall be provided.

B. Cast-in-place bolts shall typically be used for attachment of supports. Drilled anchor inserts shall generally be avoided.

C. Pipe supports, fasteners, insulation, etc. located within shallow tunnels shall be designed for high humidity (saturated) conditions. Anchors and supports shall be epoxy coated and fasteners shall be stainless steel.

D. Pipe hangers attached to walkable tunnel ceiling or structure above pipe (e.g. clevis hangers) are discouraged and shall be used only where pipe movement is minimal and bottom support is impractical.

E. Supports shall be fabricated in accordance with ASME B31.1, MSS SP-58 and MSS SP-89.

F. Supports shall be designed to support 100% flooded piping without movement or deformation.

G. Supports shall be designed and positioned to accommodate worst-case pipe movement due to thermal expansion.

H. Pipe support and hanger design shall comply with drawing details. [Note to PSC: Provide drawing details. Provide structural design as appropriate.]

2.10 PIPE ANCHORS

A. Pipe anchors shall be constructed of structural steel, welded directly to pipe.

B. Anchor plate or restraining bolts shall be cast into the structural concrete.

C. Anchors shall be constructed and positioned to prevent pipe movement without anchor deformation or movement under all operating conditions.

D. Anchors may be fabricated or factory manufactured as indicated in project documents. Anchors design shall comply with drawing details. [Note to PSC: Provide project-specific specifications and drawing details. Provide structural design as appropriate.]

2.11 PIPE GUIDES

A. Pipe guides shall be constructed of structural steel. Guides shall be positioned to maintain pipe alignment under all operating conditions.

B. Applicable requirements of paragraph above entitled PIPE SUPPORTS shall apply.

C. Guides may be fabricated or factory manufactured as indicated in project documents.

D. Guide type shall be as appropriate for application and shall comply with drawing details. [Note to PSC: Identify guide type and provide specification. Provide drawing details. Provide structural design as appropriate.]

2.12 INSULATION

A. Pipe insulation shall be in compliance with Section 23 05 19 – HVAC Piping Insulation. [Note to PSC: The referenced specification allows reduced insulation thickness for systems outside buildings. Thickness schedule shall be edited as appropriate. Consideration: It may be beneficial to provide a separate Division 33 insulation specification dedicated to utility systems.]

PART 3 - EXECUTION

3.1 EQUIPMENT LOCATION

A. Devices requiring operation and/or service shall be located in accessible vaults as indicated on drawings. [Note to PSC: Provide detailed vault design documents including structural and electrical. Include design of support systems (e.g. sump pumps).]

B. Devices requiring vault location including but not limited to following:
1. Valves
2. Warm-ups
3. Blowdowns
4. Steam traps
5. Expansion joints
6. Flexible metal hose
7. Flanged or union connections

3.2 CORROSION PROTECTION
A. All exposed carbon steel members and components located within stand-alone vaults and shallow trench tunnels shall be sand-blasted, primed and epoxy coated on all surfaces.
B. Exposed steel members and components located within walkable tunnels shall be primed and painted on all surfaces. Steel components in contact with tunnel floor shall be epoxy coated to distance 12" above floor level.

3.3 PIPE AND FITTINGS
A. Installation
1. All steam piping and condensate in tunnel steam system shall have welded joints. Exceptions: Threaded connections shall be provided for steam traps and associated strainers and check valves. Flanged connections are allowed at valves 2/1/2” and larger in pumped condensate system.
2. Welds shall be in compliance with ASME B31.1 and UIUC Facilities Standards Section 23 20 00 – Pipe Joining.
3. Backing rings shall not be used at welded joints.
4. Welder identification shall be provided for each weld. Identification shall consist of pipe stamp and welding record. Requirement for welder identification may be relaxed with written approval of PSC.
5. Interior of pipe and fittings shall be thoroughly cleaned prior to and after welding/assembly.
6. Piping shall be installed plumb and orthogonal relative to floors and walls.
7. Piping shall be located and configured to avoid interferences and maintain access to valves, devices and equipment requiring service.
8. Piping shall not be located above electrical panel boards, switchgear, switchboards or motor control centers and shall comply with requirements of National Electric Code.
9. Anchors, expansion joints, swing joints, expansion loops and guides shall be provided as required to provide/control movement and shall be provided as indicated on project drawings. [Note to PSC: Show on drawings.]
10. Piping shall be installed to facilitate insulation.
11. Horizontal steam piping shall be pitched down 1” per 40’ in direction of flow.
12. Horizontal condensate piping shall be pitched down 1” per 20’ in direction of flow.
13. Eccentric fittings shall be used for changes in pipe size in horizontal lines and shall be oriented with bottom of pipe straight.
14. “Weldolets”, “Threadolets” and “Sockolets” may be used for branch connections only if approved by PSC. Maximum size of branch shall be two pipe sizes smaller than main.
15. Unless otherwise indicated, branch steam supply piping shall be connected to top or within 45 degrees of top of main.
3.4 BLOWDOWN / DRAIN PIPING

A. Blowdown/drain piping and trap assemblies shall be provided for supervised condensate removal at each low point in main, on both sides of each main isolation valve and at each end-of-main location. See Drawing 33 63 00-1.

1. Blowdown/drain piping with trap assemblies shall be provided in mains at intervals not to exceed 300'.
2. Where space allows, blowdown/drain piping shall be connected to adequately sized drip legs.
3. Drip legs shall be full pipe size for main size 4" and smaller, 4" minimum for main size 6" and ½ pipe size for main size 8" and larger.
4. Where space is inadequate (e.g. stacked mains in tunnel), blowdown/drain piping shall be connected to horizontal “fish mouth” condensate collector at bottom of main. See Drawing 33 63 00-1.

3.5 WARM-UP LINES

A. Warm-up line with throttling valve shall be provided at each shut-off valve in main distribution piping as indicated on drawings. [Note to PSC: Show on drawings.]

3.6 VALVES

A. Required locations

1. At a minimum, valves shall be provided...
   a. In branch piping at connections to steam supply mains and pumped condensate mains as indicated on drawings.
   b. At three-valve configurations in mains.
   c. In blowdown/drain piping - two valves in series for shutoff and throttling. See Drawing 33 63 00-1.
   d. In warm-up lines at main isolation valves for throttling.
   e. At inlet and outlet of trap assemblies including trap test valve.
   f. At building entrance, first valve inside building for steam, condensate, pumped condensate.

B. Unions or flanges shall be provided for valves....

1. At trap assemblies.
2. At valves in condensate piping (trap discharge).
3. At strainers and other specialties.

C. Orientation

1. Gate and Globe Valves
   a. Steam valves installed in horizontal piping shall have stem/bonnet oriented upright within 45 degrees of vertical position. Valve may be installed with stem oriented horizontally if no option exists. In no case shall valve be installed with stem and hand wheel oriented vertically downward.

2. Ball Valves
   a. Valves may be installed in any position except with stem oriented vertically downward (i.e. with handle at bottom).
   b. Valves shall be installed such that direction of flow indication on valve body and/or product literature, if any, matches actual direction of fluid flow through valve.

3. Butterfly Valves
a. Valves shall be installed such that shaft is oriented horizontally. In no case shall valve be installed with shaft oriented vertically downward (i.e. with actuator at bottom).

b. Valves shall be installed such that direction of flow indication on valve body and/or product literature, if any, matches actual direction of fluid flow through valve.

c. High performance butterfly valves shall be pre-assembled to ensure proper disc/seat alignment. This is essential to achieve tight shut-off.

4. Check Valves
   a. Swing check valves shall be installed in horizontal pipe or vertical pipe with upward flow.

3.7 STRAINERS
   A. Wye Strainers
      1. Strainer shall be provided upstream of each steam trap and at other locations shown on drawings.
      2. Strainer shall be installed in horizontal piping or in vertical piping with downward flow.
      3. Strainer in horizontal piping shall be oriented on side to prevent collection of condensate.
      4. Strainer blowdown connection shall be fitted with nipple, valve and cap.

3.8 STEAM TRAPS
   A. Inverted Bucket Traps
      1. Drip trap assembly shall be provided at each blowdown/drain for removal of condensate during normal system operation. See Drawing 33 63 00-1. Contact Owner as required to confirm proper trap sizing for variable saturated/superheated steam.
      2. Drip leg and trap assembly shall be provided at all other low-points in system as applicable.
      3. Drip leg shall be extended and trap positioned such that trap inlet is no less than 14” below bottom of steam pipe. Where potential for superheated steam exists, trap inlet shall be no less than 28” below steam pipe. Presence of superheated steam shall be assumed unless indicated otherwise by Owner.
      4. Condensate piping shall be extended to pump located in building or tunnel.
      5. Flexible metal hose shall be provided at trap discharge as required to provide flexibility.

[Note to PSC: Trap sizing is difficult in sections of system where conditions vary between saturated and superheated. Seek assistance from Owner as needed.]

3.9 FLEXIBLE METAL HOSE
   A. Hose shall be of adequate length to maintain required bend radius at “worst case” conditions without excess length.
   B. Hose shall be oriented to prevent trapping of condensate.

3.10 EXPANSION JOINTS
   A. Packed Slip Joints
      1. Expansion joints shall be provided at locations indicated on drawings.
      2. Expansion joints shall be selected for each location to accept movement of piping over full range of travel. Generous safety factor shall be included. [Note to PSC: Indicate required expansion joint travel in project documents.]
      3. Expansion joints shall have base firmly anchored to tunnel wall. [Note to PSC: Provide drawing details. Provide structural design as appropriate.]
4. Expansion joints shall be aligned with piping to facilitate linear movement without binding.

5. Slip(s) shall be optimally positioned within body of expansion joint to accept movement of piping system over full range of temperatures. Position calculation shall incorporate actual temperature at time of installation. Positioning shall be approved by PSC at time of installation prior to making weld connection to pipe. [Note to PSC: Ensure that position is correct.]

6. Contractor’s installation shop drawings shall be submitted to PSC for approval.

3.11 PIPE SUPPORTS

A. Pipe supports shall be provided at locations indicated on drawings.

B. Installation of supports, including, spacing shall be in compliance with ASME B31.1, MSS-58 and MSS-89. [Note to PSC: Provide drawing details. Provide structural design as appropriate.]

C. Supports shall typically be anchored to floor, combination of floor and ceiling or wall of walkable tunnel or vault.

D. Pipe hangers attached to walkable tunnel ceiling or structure above pipe (e.g. clevis hangers) are discouraged and shall be used only where bottom support is impractical.

E. Supports within shallow tunnels shall be wall supported to prevent contact with water at floor level. If floor supports are required concrete pedestals shall be provided.

F. Pipe supports located within shallow tunnels shall be designed for high humidity (saturated) conditions. As stated above in the paragraph entitled Corrosion Protection supports shall be epoxy coated and fasteners shall be stainless steel.

G. Supports shall be positioned to facilitate worst-case pipe movement. Slides or rollers shall typically be provided. [Note to PSC: Provide specification for roller supports or other pre-manufactured items. Indicate locations on drawings.]

H. Pipe shoes, saddles or slides shall be welded to pipe at each support to prevent pipe abrasion and allow insulation to pass through full thickness, unbroken.

I. Contractor’s installation shop drawings shall be submitted to PSC for approval.

3.12 PIPE ANCHORS

A. Pipe anchors within piping system shall be provided at locations indicated on drawings.

B. Anchors shall be attached directly to tunnel wall unless clearly indicated otherwise in project documents.

C. Method of attachment shall be in compliance with drawing details. Note to PSC: Provide drawing details. Design shall be carefully reviewed with Owner. Failure at anchors is not uncommon.

D. Contractor’s installation shop drawings shall be submitted to PSC for approval.

3.13 PIPE GUIDES

A. Guides within piping system shall be provided at locations indicated on drawings.

B. Guides shall be positioned to maintain pipe alignment under all operating conditions.

C. Guide type shall be as appropriate for application and shall be in compliance with drawings. [Note to PSC: Provide information on drawings.]

D. Contractor’s installation shop drawings shall be submitted to PSC for approval.

3.14 PIPE JOINING

A. All welded and threaded pipe connections shall comply with requirements of ASME B31.1 and Section 23 20 00 – Pipe Joining. [Note to PSC: In lieu of the referenced Division 23
section may be beneficial to provide a separate Division 33 welding/joining specification or equivalent dedicated to utility systems."

3.15 THREADED JOINTS
A. Tapered NPT threads shall be properly cut on piping at joints.
B. Joint sealant shall be applied.
C. Torque shall be applied to properly seat threads.

3.16 FLANGED JOINTS
A. Flanges shall be properly aligned with minimal application of force.
B. Gasket shall be properly positioned.
C. Bolts shall be inserted and anti-seize compound applied.
D. Bolts shall be torqued to specified value.

3.17 WELDING
A. Qualifications
   1. All welders and welding procedure specifications (WPS) shall be qualified as set forth in ASME Boiler and Pressure Vessel Code, Section IX
      a. Welder
         1) Prior to performing project welds documentation shall be submitted confirming that each welder has passed required procedure test. Welders shall be qualified as required by ASME B31.1 or ASME B31.9 as applicable.
         2) Welder qualifications shall be current. If qualification test is more than six months old record of continuity shall be provided indicating welder has performed applicable and approved welding at least every six months since date of qualification test. Record of continuity shall be to satisfaction of PSC.
      b. Weld Procedure Specifications (WPS)
         1) Welding procedure specifications shall be provided for project specific welding methods and materials.
   B. Weld Record
      1. For welding within scope of ASME B31.1 procedure for locating, monitoring, recording and maintaining quality of welds shall be submitted to PSC for approval.
   C. Weld Inspection and Examination
      1. All welds in piping and piping components shall be carefully visually examined in accordance with ASME Standard B31.1 or ASME B31.9 as applicable.
      2. Periodically, as welding progresses, report shall be provided indicating status of project welding quality.
      3. PSC and Owner shall be provided opportunity to observe all aspects of welding prior to, during and after fabrication to assure that proper welding is provided to Owner’s satisfaction. Off-site shop welding shall be included. Additionally, Owner maintains right to obtain independent weld examination.
      4. PSC and Owner shall retain right to stop in-progress welding work until resolution of any concerns are resolved to Owner’s satisfaction. Such shall be at no cost to Owner.
      5. Welds in piping and piping components shall be radiographically examined only as indicated in project documents. Radiographic examination shall be in accordance with ASME B31.1. Number or percentage of welds to be examined shall be as indicated in project documents. Specific welds to be examined shall be selected by PSC. Testing agency shall be approved by PSC and Owner.
D. Welding Procedure

1. All welding shall comply with applicable requirements of referenced ASME and AWA Standards.
2. Backing rings shall not be used with welded joints.
3. All fittings shall be factory standard fittings. Fabricated fittings not allowed.
4. Welds shall be built up with stringer-bead pass followed by hot pass, followed by cover or filler pass.
5. Valleys at center or edges of welds not allowed. Unsound or unfused metal, cracks, oxidation, blow holes or non-metallic inclusions not allowed. Any such imperfections shall be corrected in compliance with referenced standards and to satisfaction of PSC and Owner.
6. When hot-tapping, slag, drillings or “cookies” shall be prevented from entering piping system to greatest degree possible. Any material that enters piping shall be removed by use of magnet after drilling or cutting is complete.
7. Each weld shall be painted shortly after completion to prevent corrosion.

3.18 LEAK TESTING

A. All Leak Tests, Requirements

1. Leak test shall be performed in presence of Owner’s representative. 72 hour advance notification shall be provided.
2. Piping system shall be uninsulated at time test is performed.
3. Leak test may be made of isolated portions of system to facilitate general progress of installation.
4. Valves within test segment shall be opened including isolation valves for devices and instrumentation rated for test pressure.
5. Equipment, components and instrumentation not rated for test pressure or vulnerable to damage shall be isolated.
6. Test gauge shall be used for accurately monitoring system pressure.
   a. At a minimum, gauge shall comply with applicable requirements of Section 23 05 19 – Meters and Gauges for HVAC Piping.
   b. At a minimum, gauge shall be ANSI Grade AA (2A), ½% full scale accuracy.
7. Test pressure shall be maintained on system after pressure test is complete. Piping, joints and connections shall be visually inspected for leakage by qualified inspector.
8. If leakage occurs, corrective measures shall be taken to eliminate leak. Repairs shall be made in accordance with applicable codes and standards and to satisfaction of PSC and Owner. Repair and retesting shall be performed until successful test is achieved as defined above.
9. After test is completed relief valves, if any, shall be reinstalled and valves and components restored to operating position/configuration.
10. If any alteration is made to piping system after completion of test, applicable section of piping system shall be retested.
11. Written report shall be submitted to PSC.

B. Hydrostatic Test
1. System shall be filled with clean water and air shall be vented from all piping and devices.
2. System shall be hydrostatically tested to 1.5 design pressure.
3. Test pressure shall be held for 2 hours minimum with no detectible drop in gage pressure.
4. Water shall be drained from system.

C. Hydrostatic Test Exception
1. If it is deemed dangerous or potentially damaging to proceed with hydrostatic test against hot components of adjacent operating system, following options may be pursued as approved by PSC and Owner:
   a. Temporary caps shall be installed to facilitate hydrostatic testing of new system with exception of final connection to existing hot system. After test is complete final connection to existing hot system shall be made and system activated. Visible test of final connections shall be performed. If system fails to pass test, repair shall be performed and system retested.
   b. Air test shall be performed in lieu of hydrostatic test. In such case, connections shall be made to existing hot system and air test of entire new system performed. If system fails to pass test, applicable procedure outlined above for repair and retest applies.

3. Air Test, As Applicable
   1. Compressed air shall be applied to system.
   2. System shall be air tested to 110% of system design pressure.
   3. Test pressure shall be held for 2 hours minimum with no detectible drop in gage pressure.
   4. Air pressure shall gradually be relieved.

3.19 PREOPERATIONAL CLEANING, STEAM SYSTEMS
A. Traps and Strainers
   1. All strainers in steam and condensate systems shall be temporarily removed.
   2. All steam traps shall be temporarily disconnected from steam and condensate supply piping.
B. Hand Cleaning
   1. Slag, burrs, solder, thread sealant, etc. shall be physically removed from interior of installed piping system to degree practical as determined by PSC and Owner.
C. Steam Supply Piping
   1. Manual and automatic control valves shall be moved to open or closed position as appropriate for flushing.
   2. Devices vulnerable to damage or fouling shall be protected from contamination by valving off, disconnecting from piping, installing bypass piping, installing temporary “pancakes” at flanged connections or other method approved by PSC and Owner.
   3. All steam supply piping including drip legs and low points shall be filled with clean water and continuously flushed to sanitary drain until effluent is clean to satisfaction of PSC and Owner.
   4. All steam supply piping shall be energized with live steam after any required reassembly has been accomplished. Supply piping shall be allowed to “cook” for 12 hours minimum while contaminated condensate is safely captured, cooled and conveyed to drain. Process shall include drip legs and other low points in system.
Procedure shall be continued until clean condensate is achieved to satisfaction of PSC and Owner. Minimum “cook” time may be reduced by PSC and Owner if deemed appropriate.

D. Condensate Piping

1. All steam traps shall be disconnected from condensate piping. Steam traps shall be protected from contamination and shall not be cleaned or flushed internally.

2. All condensate piping including low points shall be filled with clean water and continuously flushed to sanitary drain until effluent is clean to satisfaction of PSC and Owner.

3. After flushing is complete, condensate return unit receiver(s) shall be flushed to drain until clean.

E. Reassembly

1. Strainers shall be reinstalled.

2. Steam traps shall be reconnected.

3.20 ADDITIONAL REQUIREMENTS

A. Preoperational cleaning of selected steam systems

[Note to PSC: Identify and specify additional cleaning requirements for selected steam systems as applicable. Abbreviated example follows:]

1. Steam Blow Cleaning
   a. Additional high velocity steam blow cleaning shall be accomplished for critical systems or portions thereof as identified within documents.
   b. Industry standard procedures shall be applied. Project specific scope and requirements shall be as established by PSC or Owner.

3.21 PIPE COATING

A. Steam and condensate piping shall receive corrosion protective coating prior to insulating as identified and specified within project documents.

[Note to PSC: Identify piping to be coated and provide specification for coating system. Such coating is required for steam and condensate piping located within shallow trench tunnels, stand-alone vaults and similar high temperature, high humidity areas. The University has consistently experienced serious corrosion problems with steel components within shallow tunnels and vaults, including insulated piping. Discuss requirement and specification with F&S Utilities Distribution.]

3.22 INSULATION

A. After leak testing is complete steam and condensate piping shall be insulated in compliance with Section 23 05 19 – HVAC Piping Insulation. [Note to PSC: The referenced specification allows reduced insulation thickness for systems outside buildings. Thickness schedule shall be edited as appropriate. Consideration: It may be beneficial to provide a separate Division 33 insulation specification dedicated to utility systems.]

END OF SECTION 33 63 00