

**SECTION 23 21 11**  
**BOILER PLANT PIPING SYSTEMS**

**PART 1 - GENERAL:**

**1.1 DESCRIPTION:**

All boiler plant piping systems, except plumbing and sanitary, including piping supports. Piping located outside of the boiler plant building is not included except for gas regulator and meter stations.

**1.2 RELATED WORK:**

- A. Section 23 05 10, COMMON WORK RESULTS FOR Boiler Plant and STEAM GENERATION
- B. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- C. Section 23 07 11, HVAC and BOILER PLANT INSULATION.
- D. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
- E. Control valves: Section 23 52 33 20, HEAT RECOVERY STEAM GENERATOR (HRSG).
- F. Control valves: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- G. Flow Meters: Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- G. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

**1.3 QUALITY ASSURANCE:**

- A. Entire installation shall comply with ASME Power Piping Code, ASME B31.1 and appendices.
- B. Boiler External Piping, as defined in the ASME Boiler and Pressure Vessel Code, Section I, is required to be constructed and inspected in conformance with the ASME Code.
- C. Mechanics shall be skilled in their work or trade. Welders on pressure vessels or piping shall show evidence of qualification in accordance with the ASME Power Piping Code and the ASME Boiler and Pressure Vessel Code. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current. Each welder shall utilize a stamp to identify all work performed by the welder. The Government reserves the right to reject any personnel found unqualified in the performance of work for which they are employed.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Piping:
  - 1. ASTM material specification number.
  - 2. Grade, class or type, schedule number.
  - 3. Manufacturer.
- C. Pipe Fittings, Unions, Flanges:
  - 1. ASTM material specification number.
  - 2. ASME standards number.
  - 3. Catalog cuts.
  - 4. Pressure and temperature ratings.
- D. Valves - Gate, Globe, Check, Plug, Butterfly, Ball:
  - 1. Catalog cuts showing design and construction.
  - 2. Pressure and temperature ratings.
  - 3. Materials of construction.
  - 4. Accessories.
- E. Sight flow indicators:
  - 1. Catalog cuts showing design and construction.
  - 2. Pressure and temperature ratings.
  - 3. Materials of construction.
- F. Pressure Reducing and Regulating Valves, Back Pressure Relief Valves, Safety Valves, Relief Valves:
  - 1. Catalog cuts showing design and construction.
  - 2. Service limitations (type of fluid, maximum pressure and temperatures).
  - 3. Materials of construction.
  - 4. Flow capacity at required set pressure.
  - 5. Predicted sound levels, at operating condition, for steam pressure reducing valves.
- G. Strainers:
  - 1. Catalog cuts showing design and construction.
  - 2. Pressure and temperature ratings.
  - 3. Materials of construction.
  - 4. Strainer basket or liner mesh.
  - 5. Pressure loss and flow rate data.
- H. Emergency Gas Safety Shutoff Valves:
  - 1. Catalog cuts showing design and construction.

2. Maximum pressure rating.
3. Material of construction.
4. Pressure loss and flow rate data.

I. Steam Traps:

1. Catalog cuts showing design and construction.
2. Service limitations (maximum pressures and temperatures).
3. Materials of construction.
4. Flow rates at differential pressures shown on drawings.
5. Orifice size for each trap.

J. Flexible Connectors:

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Materials of construction.
4. Maximum allowable lateral and axial movements.
5. Description of type of movement permitted, intermittent offset or continuous vibration.

K. Pipe Support Systems:

1. Credentials of technical personnel who will design the support systems.
2. Validation of computer program for pipe support selection.
3. Input and output data for pipe support selection program for all piping systems with pipe sizes 60 mm (2-1/2 inches) and above.
4. Boiler and feedwater deaerator steam nozzle (pipe connection) allowable and actual forces and moments imposed by connecting piping.
5. Hanger load calculation methods and results for piping systems with pipe sizes 50 mm (2 inches) and below.
6. Piping layouts showing location and type of each hanger and support.
7. Catalog cuts showing design and construction of each hanger and support and conformance of hangers and supports to MSS standards.
8. Drawings showing arrangement and sizes of all components comprising each spring-type hanger and support assembly.
9. Load rating and movement tables for all spring hangers, and seismic shock absorbing devices.

**1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:**

All piping shall be stored and kept free of foreign material and shall be internally and externally cleaned of all oil, dirt, rust and foreign material. Deliver and store valves and pipe hangers in sealed shipping

containers with labeling in place. Storage must be in dry, protected location.

#### **1.6 INFORMATION ON PRESSURE-TEMPERATURE DESIGN OF PIPING SYSTEMS:**

- A. Steam service pressures are selected to provide optimum pressure to the facilities served by the boiler plant. Main steam header pressure shall be controlled at 815 kPa (120 psi). Maximum pressure capability of steam systems between boilers and through first pressure reducing valve protected by a safety valve shall be governed by the pressure/temperature relationship of the highest safety valve setting shown for the boilers.
- B. Steam distribution systems protected by safety valves following pressure reducing stations or protected by safety valves on the boilers shall be governed by the pressure/temperature relationship developed by the maximum setting of the safety valve on that system.
- C. Boiler feedwater systems between boiler feed pumps, economizers (if provided), and boilers are designed for a normal maximum temperature of 138 degrees C (280 degrees F), and emergency temperature of 213 degrees C (415 degrees F) (if economizers are provided and economizer safety relief valve setting is 1896 kPa (275 psi)). Design pressure is the greater of: boiler feed pump shut off head; or 1896 kPa (275 psi) set pressure, plus accumulation, of economizer (if provided) relief valve.
- D. Condensate collection and transfer systems to suction of boiler feed pumps are designed for maximum temperatures to 100 degrees C (212 degrees F), and pressures 276 kPa (40 psi). Vacuum return systems shall operate between 0 and 27 kPa (0 and 8 inch Hg) vacuum and equivalent steam saturation temperatures.
- E. Natural gas fuel systems for the HRSG are designed and materials and equipment are applied to prevent failure under gas pressure of 100 kPa (15 psi) entering the Energy Center. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 1725 kPa (250 psig). The natural gas fuel system for the turbine enters the Energy Center at 50 psi.
- F. Water service pressures are 545 kPa (80 psi) maximum. Systems are designed to operate under conditions of maximum available pressure.
- G. Drips, drains, blowdown, water sampling, and chemical treatment are designed, and materials and equipment are applied in accordance with the maximum pressure and temperature of the system with which they are associated.

- H. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psi) saturated steam.
- I. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).
- J. Instrumentation and control piping shall be provided for the service and pressure characteristics of the systems to which they are connected.

#### 1.7 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. ASTM International (ASTM):
  - A47/A47M-99(2009).....Standard Specification for Ferritic Malleable Iron Castings
  - A48/A48M-03(2008).....Standard Specification for Gray Iron Castings
  - A53/A53M-10.....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  - A105/A105M-10.....Standard Specification for Carbon Steel Forgings for Piping Applications
  - A106/A106M-10.....Standard Specification for Seamless Carbon Steel Pipe For High Temperature Service
  - A126-04(2009).....Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
  - A193/A193M-10.....Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
  - A194/A194M-10.....Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
  - A197/A197M-00(2006).....Standard Specification for Cupola Malleable Iron
  - A216/A216M-08.....Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High Temperature Service

- A234/A234M-10.....Standard Specification for Piping Fittings of  
Wrought Carbon Steel and Alloy Steel for  
Moderate and High Temperature Service
- A269-10.....Standard Specification for Seamless and Welded  
Austenitic Stainless Steel Tubing for General  
Service
- A395/A395M-99(2009).....Standard Specification for Ferritic Ductile  
Iron Pressure-Retaining Castings for use at  
Elevated Temperatures
- A536-84(2009).....Standard Specification for Ductile Iron  
Castings
- B61-08.....Standard Specification for Steam or Valve  
Bronze Castings
- B62-09.....Standard Specification for Composition Bronze  
or Ounce metal Castings
- B88/B88M-09.....Standard Specification for Seamless Copper  
Water Tube
- C. American Society of Mechanical Engineers (ASME):
- Boiler and Pressure Vessel Code: 2010 Edition with current Addenda
- Section I.....Power Boilers
- Section IX.....Welding and Brazing Qualifications
- B16.3-2006.....Malleable Iron Threaded Fittings
- B16.4-2006.....Gray Iron Threaded Fittings
- B16.5-2009.....Pipe Flanges and Flanged Fittings: NPS ½  
Through 24
- B16.9-2007.....Factory Made Wrought Buttwelding Fittings
- B16.11-2009.....Forged Fittings, Socket-Welding and Threaded
- B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint  
Pressure Fittings
- B31.1-2010.....Power Piping
- D. Manufacturers Standardization Society of the Valve and Fittings  
Industry (MSS):
- SP-45-03(2008).....Bypass and Drain Connections
- SP-58-2009.....Pipe Hangers and Supports-Materials, Design,  
Manufacture, Selection, Application, and  
Installation
- SP-69-2003.....Pipe Hangers and Supports-Selection and  
Application

- SP-80-2008.....Bronze, Gate, Globe, Angle and Check Valves
- SP-89-2003.....Pipe Hangers and Supports-Fabrication and  
Installation Practices
- SP-90-2000.....Guidelines on Terminology for Pipe Hangers and  
Supports
- SP-97-2006.....Integrally Reinforced Forged Branch Outlet  
Fittings - Socket Welding, Threaded and  
Buttwelding Ends
- SP-127-2001.....Bracing for Piping Systems Seismic - Wind -  
Dynamic Design, Selection, Application
- E. National Fire Protection Association (NFPA):
- 30-2008.....Flammable and Combustible Liquids Code
- 31-2011.....Standard for the Installation of Oil Burning  
Equipment
- F. American Welding Society (AWS):
- B2.1-2009.....Specification for Welding Procedure and  
Performance Qualification
- G. Pipe Fabrication Institute (PFI):
- PFI ES-24-08.....Pipe Bending Methods, Tolerances, Process and  
Material Requirements
- H. U.S. Department of Veterans Affairs (VA):
- VHA Boiler Plant Safety Device Testing Manual

## **PART 2 - PRODUCTS:**

### **2.1 STEAM PIPING:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or electric resistance welded (ERW). Schedule 40 for piping up to 862 kPa (125 psig) with welded ends, Schedule 80 for piping with threaded ends and piping over 862 kPa (125 psig) with welded ends. Standard weight permitted for pipe sizes 300 mm (12 inches) and above.
- B. Joints:
1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded or socket-welded.
- C. Fittings:
1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius.

- 2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
- 3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class.
- D. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) on piping 50 mm (2 inches) and under.
- E. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi) pressure class, except 2050 kPa (300 psi) class required adjacent to 1725 kPa (250 psi) and 2050 kPa (300 psi) class valves. Bolts shall be high strength steel ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

## **2.2 STEAM CONDENSATE PIPING:**

- A. Includes all gravity, drip return, pumped and vacuum systems. Does not include piping system between boiler feed pumps and boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 80.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded or socket-welded.
- D. Fittings:
  - 1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
  - 3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- E. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (30 psi). On piping 50 mm (2 inches) and under.
- F. Flanges: Forged steel weld neck, ASTM A105, ASME B16.5, 1025 kPa (150 psi).

## **2.3 FUEL PIPING:**

- A. Natural gas and LP gas (propane) for main burner and igniter (pilot) fuels, gas vent piping. Comply with ASME B31.1.



- B. Piping: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40. Fuel oil piping shall be seamless downstream of burner automatic shutoff valves.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Socket-welded or butt-welded.
- D. Fittings:
  - 1. Butt-welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class).
- E. Unions on piping 50 mm (2 inches) and under: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class.
- F. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).
- G. Companion flanges: Flanges and bolting shall conform to ASME B16.5.
- H. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B31.1, for the actual operating conditions.
- I. Igniter (Pilot) Piping: Furnished as part of the factory assembled burners may have 2050 kPa (300 psi) ASTM A47, ASME B16.3 malleable iron threaded fittings in lieu of welded steel. If threaded fittings are provided, piping shall be Schedule 80.

#### **2.4 BOILER FEEDWATER PIPING:**

- A. Piping from boiler feedwater pump discharge to inlet of boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW. Piping with threaded joints shall be Schedule 80; welded joints Schedule 40.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (two inches) and below: Threaded, butt-welded or socket-welded.
- D. Fittings:
  - 1. Butt-welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Threaded Joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47, ASME B16.3, 2050 kPa (300 psi) class.

3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable or ductile iron, 2050 kPa (300 psi) class.

F. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi) pressure class. Bolts shall be High strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

## **2.5 BOILER BLOWOFF PIPING:**

A. From boiler bottom blowoff connection to blowoff tank. Connections between boiler accessories drain valves and blowoff lines.

B. Pipe: Carbon steel, ASTM A106, Grade B, seamless, Schedule 80.

C. Joints: Butt-welded.

D. Fittings: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius, no tees or crosses permitted.

E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi).

## **2.6 DRAIN PIPING FROM BOILER ACCESSORIES TO DRAIN VALVE:**

A. Drain piping from water column, low water cutoffs, gauge glass, water level sensor, remote water level devices (where applied).

B. Pipe: Carbon steel, ASTM A106, seamless, Schedule 40.

C. Joints: Threaded.

D. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.

E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) class.

## **2.7 VENT LINES FROM TANKS AND SAFETY AND RELIEF VALVES:**

A. Pipe: Carbon steel, ASTM A53 Grade B or A106 Grade B, seamless or ERW, Schedule 40.

B. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.

2. Pipe sizes 50 mm (2 inches) and below: Threaded or butt-welded.

C. Fittings:

1. Welded Joints: Steel, ASTM A234 Grade B, ASME B16.9, same schedule as adjoining pipe.

2. Threaded Joints: Cast iron, ASME B16.4, 850 kPa (125 psi).

D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

## **2.8 COLD WATER PIPING:**

- A. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

## **2.9 COMPRESSED AIR PIPING:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW Schedule 40.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron ASTM A47 or A197, ASME B16.3, 1025 kPa (150 psi) class.
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

## **2.10 COMPRESSED AIR AND BOILER DRAFT GAUGE PIPING (PNEUMATIC CONTROL AND INSTRUMENTATION):**

- A. Air drier to utilization point; draft gauge sensing lines.
- B. Copper tubing, hard drawn, ASTM B88, Type L.
- C. Fittings: Wrought copper, ASME B16.22, soldered.
- D. Draft Gauge Piping: 6 mm (1/4 inch) pipe size minimum.

## **2.11 BOILER WATER SAMPLING, CONTINUOUS BLOWDOWN:**

- A. Pipe: Steel, ASTM A106 Grade B, seamless, Schedule 80.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class. Fittings between boiler and first stop valve must be forged steel, ASME B16.11, 13,790 kPa (2000 psi) or 20,700 kPa (3000 psi) class.
- D. Unions: Malleable iron, 2050 kPa (300 psi) class.

## **2.12 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING:**

- A. Pipe: Stainless steel tubing, ASTM A269, Type 316.
- B. Fittings: Stainless steel Type 316 welding fittings.

## **2.13 MISCELLANEOUS PIPING:**

- A. Instrument and Control Piping (Sensing Point to Transmitter, Controller, or Other Instrument): Construction shall be same as specified for main service.
- B. Drain Piping (All Drain Piping Discharging to Floor Drain-From Drain Valve to Floor Drain):
  - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40.

2. Fittings and Unions: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, 1025 kPa (150 psi), threaded.

C. Pump Recirculation:

1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, double extra strong. Schedule 40 permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
2. Joints: Threaded.
3. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class, except 1025 kPa (150 psi) class permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
4. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, ASTM A47 or A197, same pressure class as nearest fittings.

**2.14 DIELECTRIC FITTINGS:**

Provide threaded dielectric unions for pipe sizes 50 mm (2 inches) and under. For 65 mm (2-1/2 inches) and above, provide copper and steel flanges electrically isolated at gasket and by sleeves at bolts. Fittings on cold water and soft water lines shall be rated for 690 kPa (100 psi), 27 degrees C (80 degrees F). Fittings on steam condensate lines shall be rated at 510 kPa (75 psi), 120 degrees C (250 degrees F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

**2.15 VALVES; GATE, GLOBE, PLUG, CHECK, BALL, BUTTERFLY, VENT COCKS:**

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer. Comply with MSS SP-45, MSS SP-80, and ASME B31.1. Design valves for the service fluids and conditions. Pressure-temperature ratings listed are minimum requirements. Packing and gaskets shall not contain asbestos.
- B. Valve Type Designations:
  1. Gate Valves:
    - a. Type 101: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 degrees C (150 psi at 500 degrees F), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.

- 1) Provide factory installed globe-valved warm-up bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
  - 2) Drill and tap bosses for connection of drains. Conform to MSS SP-45.
- b. Type 102: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze wedge and seats, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
- 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
  - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
- c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
- 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
  - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
- d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
- e. Type 105: Forged steel body ASTM A105, rated for 2050 kPa at 216 degrees C (300 psi at 420 degrees F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
2. Globe Valves:
- a. Type 201: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 degrees C (150 psi at 500 degrees F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet,

renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.

- b. Type 202: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
  - c. Type 203: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
  - d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.
  - e. Type 205: Forged steel body ASTM A105, rated for 2050 kPa at 216 degrees C (300 psi at 420 degrees F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), stainless steel disc, stellite seat, threaded ends, OS&Y, rising stem, bolted bonnet.
3. Plug Valves: Cast iron body ASTM A126 Class B, rated for 1200 kPa (175 psi) WOG, one-fourth turn to open. 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. All components designed for service to which applied: natural gas, LP gas (propane), or fuel oil. Furnish lever handle for each valve.
- a. Type 301: Two-way valves up through 100 mm (4 inches) pipe size. Eccentric action, non-lubricated plug with resilient seal molded into groove on plug face providing bubble-tight shut off. O-ring stem seal, corrosion-resistant bearings, corrosion-resistant seat coating, seal materials as recommended by valve manufacturer for the service. Valves on natural gas service AGA approved.
  - b. Type 302: Two-way valves 125 mm (5 inches) pipe size and above, all sizes of three way valves. Lubricated full-port plug type with lubricant for intended service. Reinforced Teflon stem seal, valve plug floated on Teflon surfaces, lubricant injection system that has sufficient pressure to fully lubricate all sealing

surfaces. Provide laminated plastic label attached to each valve stating, "Lubricate with (Insert appropriate description) once a year".

4. Check Valves:

- a. Type 401: Not used.
  - b. Type 402: Swing-type, cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze-faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - c. Type 403: Swing-type, cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - d. Type 404: Swing-type, bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.
  - e. Type 405: Lift-type, forged steel body ASTM A105, rated for 2050 kPa at 216 degrees C (300 psi at 420 degrees F) minimum (Class 4130 kPa (600 psi) or 5500 kPa (800 psi)), hardened stainless steel disc, hard faced seat, bolted cover, threaded ends.
  - f. Type 406: Swing-type, Type 316 stainless steel body, disc and hanger, rated for 1725 kPa at 182 degrees C (250 psi at 360 degrees F) minimum.
  - g. Type 407: Silent spring-loaded wafer type, cast iron body ASTM A48 or A126 Class B, rated for 850 kPa (125 psi) water, 121 degrees C (250 degrees F).
  - h. Type 408: Silent spring-loaded wafer type, cast steel ASTM A216 WCB or cast iron ASTM A48 or A126 body, rated for 2050 kPa (300 psi) water, 121 degrees C (250 degrees F), stainless steel trim.
5. Ball Valves: Reduced port permitted for bypass (throttling) service; full port required for all other services, one-fourth turn to open.
- a. Type 501: Type 316 stainless steel body, ball and stem, rated for 1025 kPa at 185 degrees C (150 psi at 365 degrees F), 4130 kPa at 93 degrees C (600 psi at 200 degrees F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.
  - b. Type 502: Bronze body, rated for 1025 kPa at 185 degrees C (150 psi at 365 degrees F), 1725 kPa at 121 degrees C (250 psi at 250 degrees F), reinforced TFE seat, stem seal and thrust washer; end

entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.

- c. Type 503: Carbon steel or ASTM B61 bronze body, steam service, rated for 1380 kPa at 200 degrees C (200 psi at 390 degrees F), stainless steel ball and stem, Polyfil seat, live-loaded or adjustable stem seal, threaded ends.
- d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, ASME flanged ends.

#### 6. Butterfly Valves:

- a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa at 120 degrees C (125 psi at 250 degrees F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, lever operator.
- b. Type 602: Carbon steel body, triple-offset design, lug or flanged type, rated for steam service at 1025 kPa at 260 degrees C (150 psi at 500 degrees F), stainless steel nitrided disc, stainless steel seat, stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.

#### 7. Gas Vent Cocks:

- a. Type 701: Bronze body, tee handle, rated for 205 kPa at 38 degrees C (30 psi at 100 degrees F), ground plug, rated for tight shut-off on fuel gas service.

### C. Boiler Valves:

#### 1. Steam Non-Return Stop Check Valves:

- a. Type: Straight-way Y-pattern, with dash-pot and piston and tapped drain openings, OS&Y, bolted bonnet, rising stem. Provide angle pattern only if shown on the contract drawings.
- b. Construction: Cast steel body ASTM A216 WCB, rated for 2050 kPa (300 psi) saturated steam, stellite faced steel disc, alloy steel seat, 2050 kPa (300 psi) ASME flanged ends.
- c. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering.



2. Stop Valves for Soot Blower, Steam Vents on Boiler Drums and Steam Lead, Steam Pressure Gauge:
  - a. Installation of steam pressure gauge shut-off valves shall conform to ASME Boiler and Pressure Vessel Code, Section I.
  - b. Soot blower angle stop valves (water tube boilers), OS&Y, chain operated, cast or forged steel, 1375 kPa (200 psi) steam rating, renewable seat and disc.
  - c. Gate valves, two inches and under: Type 105.
3. Valves in Drain Lines from Steam Stop-Check Valve, Water Column, Gauge Glass, Low Water Cut-offs, Soot Blower:
  - a. Gate valves, two inches and under: Type 105.
  - b. Check valves, two inches and under: Type 405.
4. Bottom Blowoff Valves:
  - a. Type: Seatless, sliding plunger, OS&Y, designed for blowoff service. Sliding disc-type or globe-type valves are not permitted.
  - b. Construction: ASTM A216 WCB cast steel body, rated for 2050 kPa (300 psi) saturated steam, 2050 kPa (300 psi) ANSI flanged ends. Valves shall have handwheel with rotating handle.
  - c. Conform to ASME B31.1.
- D. Steam above 100 kPa (15 psi), all valves in steam pressure reducing stations:
  1. Gate valves, 50 mm (2 inches) and under: Type 105.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.
  3. Globe valves, 50 mm (2 inches) and under: Type 205.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
  5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  6. Ball valves, 50 mm (2 inches) and under: Type 503.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- E. Steam 100 kPa (15 psi) and under:
  1. Gate Valves, 50 mm (2 inches) and under: Type 104.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  3. Globe valves, 50 mm (2 inches) and under: Type 204.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
  5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  6. Ball valves, 50 mm (2 inches) and under: Type 503.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- F. Boiler Feedwater from Pumps to Boilers, Recirculation:

1. Gate valves, 50 mm (2 inches) and under: Type 105.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 102.
  3. Globe valves, 50 mm (2 inches) and under: Type 204 or 205.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 202.
  5. Check valves, at boiler feed pump discharge: Type 408.
  6. Check valves, at boiler, 50 mm (2 inches) and under: Type 405.
  7. Check valves, at boiler, 65 mm (2-1/2 inches) and above: Type 402.
- G. Boiler Water Sampling, Continuous Blowdown:
1. Gate Valves, 50 mm (2 inches) and under: Type 104.
  2. Globe valves, 50 mm (2 inches) and under: Type 204.
  3. Check valves, 50 mm (2 inches) and under: Type 404.
  4. Ball valves, 50 mm (2 inches) and under: Type 502.
  5. Continuous Blowdown Flow Control Valve: Bronze or forged steel angle-type body, rated for 2050 kPa at 288 degrees C (300 psi at 550 degrees F), hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Furnish valve blowdown chart showing flow rate versus valve opening based on 850 kPa (125 psi) boiler drum pressure.
- H. Fuel Gas: Main fuel and igniter (pilot) systems.
1. Plug valves, 100 mm (4 inches) and under: Type 301.
  2. Ball valves, 50 mm (2 inches) and under: Type 502. May be applied where plug valves are shown.
  3. Plug valves, 125 mm (5 inches) and above: Type 302.
  4. Plug valves, three-way, all sizes: Type 302.
  5. Check valves, 50 mm (2 inches) and under: Type 404.
  6. Vent cocks, 15 mm (1/2 inch) and under: Type 701.
- I. Compressed Air:
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Ball valves, 50 mm (2 inches) and under: Type 502.
- P. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- Q. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- R. Instrumentation and Control Piping:
- Ball valves, 50 mm (2 inches) and under: Type 502.
- S. Non-Boiler Blowdowns, Drains, Flow Sensing Lines:
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Ball valves, 50 mm (2 inches) and under: Type 503

**2.16 SIGHTFLOW INDICATORS:**

- A. Provide, where shown, to allow observation of flow in piping systems.
- B. Type: In line, dual portholes on opposite sides, with safety shield, with or without rotor as shown on the drawings. Where provided, rotor shall have minimum of three vanes.
- C. Construction: Cast iron or bronze body, tempered borosilicate window, PTFE seals (except Buna-N on oil service), threaded ends on pipe sizes under 65 mm (2-1/2 inches), flanged ends on sizes 65 mm (2-1/2 inches) and above. Pressure and temperature ratings shall be equivalent to requirements for valves on the same pipelines.
- D. Safety Shield: Transparent wrap-around overlap covering entire sightflow indicator, designed to protect personnel from failure of indicator. Shield shall fit the indicator tightly and be suitable for 1030 kPa, 150 degrees C (150 psi, 300 degrees F).

**2.17 SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES AND ACCESSORIES:**

- A. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure. All valves shall comply with ASME Boiler and Pressure Vessel Code (Section I and VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
- B. Boiler and Economizer Service: Refer to Section 23 52 33.20, HEAT RECOVERY STEAM GENERATOR.
- C. Steam Service (Pressure Vessels and Piping Systems): Refer to schedules on drawings for set pressures and capacities. Provide lifting levers, stainless steel trim, lapped seats on cast iron valves, EPDM o-rings on bronze valves.
- D. Fuel Oil Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- E. Compressed Air Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- F. Drip Pan Ells: Cast iron factory-built safety valve discharge fitting with pipe-within-pipe slip-type connection to vertical vent pipe, basin for collecting condensate from vent pipe, drain connections on basin and at base of ell.

**2.18 STRAINERS, SIMPLEX BASKET TYPE**

- A. Provide on condensate lines where shown. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT, for duplex basket strainers at oil pumps.

- B. Type: Simplex cylindrical basket type, clamp cover, closed-bottom, removable basket, drain at bottom with threaded plug.
- C. Service: Water at 100 degrees C (212 degrees F), 100 kPa (15 psi) maximum pressure.
- D. Construction:
  - 1. Body: Cast iron rated for 850 kPa (125 psi) ASME flanged ends, flow arrows cast on side.
  - 2. Basket: Stainless steel, 3 mm (0.125-inch) perforations. Ratio of screen open area to cross section of pipe; four to one minimum.

## 2.19 STRAINERS, Y-TYPE

- A. Provide as shown on steam, water and compressed air piping systems.
- B. Type: Open-end removable cylindrical screen. Threaded blow-off connection.
- C. Construction:
  - 1. Steam Service 420 to 1025 kPa (61 to 150 psi): Cast steel rated for 1025 kPa (150 psi) saturated steam with 1025 kPa (150 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, rated for saturated steam at 1025 kPa (150 psi) threaded ends, for pipe sizes 50 mm (2 inches) and under.
  - 2. Steam Service 415 kPa (60 psi) and under, water (except boiler feed between feedwater pumps and boilers), compressed air: Cast iron rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, with 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, for pipe sizes 50 mm (2 inches) and under.
  - 3. Boiler Feed between Feedwater Pumps and Boilers: Cast steel rated for 1725 kPa at 232 degrees C (250 psi at 450 degrees F) with 2050 kPa (300 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 1725 kPa at 232 degrees F (250 psi at 450 degrees F) for pipe sizes 50 mm (2 inches) and under.
- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. For strainers 80 mm (3 inch) pipe size and smaller, diameter of openings shall be 0.8 mm (0.033 inch) or less on steam service, 1.3 mm (0.05 inch) or less on water service, 0.3 mm (0.01

inch) or less on compressed air service. For strainers 100 mm (4 inch) pipe size and greater, diameter of openings shall be 1.3 mm (0.05 inch) on steam service, 3 mm (0.125 inch) on water service. Provide 80 mesh stainless steel screen liner on all strainers installed upstream of water meters or control valves.

- E. Accessories: Gate or ball valve and quick-couple hose connection on all blowoff connections. These items are specified elsewhere in this section.

## **2.20 STEAM TRAPS**

- A. Application: Steam line drip points and heat exchangers. Each type furnished by a single manufacturer.
- B. Type: Inverted bucket type with thermostatic vent in bucket except closed float-thermostatic on discharge side of pressure reducing stations and on all heat exchangers. Refer to the drawings for trap locations, capacity and size, differential operating pressures, and design pressure.
- C. Bodies: Cast iron or stainless steel. Construction shall permit ease of removal and servicing working parts without disturbing connected piping.
- D. Floats: Stainless steel.
- E. Valves: Hardened chrome-steel.
- F. Mechanism and Thermostatic Elements: Stainless steel mechanisms. Bimetallic strip air vent on inverted bucket traps.
- G. Trap Performance Monitoring Systems: All traps shall be provided with electronic monitoring devices. These devices shall be compatible with the existing monitoring system so that trap malfunctions will be automatically transmitted to and properly interpreted by the existing monitoring system. Provide all necessary power sources, transmitting and retransmitting devices and batteries to achieve a properly operating system. The existing monitoring system is Armstrong Steam Eye and Steam Star.
- H. Provision for Future Trap Monitoring System: All traps shall include ports for future installation of monitoring devices. Ports shall be plugged. To facilitate future removal of the plugs, install them with Teflon tape on the threads.
- I. Identification: Label each trap at the factory with an identification number keyed to number that is shown on the drawings. Label shall be a metal tag permanently affixed to the trap.

- J. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, trap monitoring device or ports for future monitoring device, and valved test ports, provide factory-packaged trap station including these features.

## **2.21 FLEXIBLE CONNECTORS**

- A. Provide flexible connectors as shown to allow differential movements of pumps and piping systems subject to thermal expansion, to serve as vibration isolators between air compressors and piping systems, and to allow connection of steam or compressed air atomizing media for oil burners on water tube boilers.
- B. Units for Water Service
1. Service: Refer to schematic diagrams for pressure, temperature and movement requirements. If requirements are not shown on the drawings, units shall be designed for maximum system pressure, temperature, axial movement and lateral movement.
  2. Construction
    - a. Teflon Bellows Type: Molded Teflon bellows with metal reinforcing rings, flanged ends, bolted limit rods.
    - b. Stainless Steel Bellows Type: Multi-ply stainless steel with flanged ends, bolted limit rods.
    - c. Flexible Metal Hose Type: Corrugated stainless steel or bronze hose wrapped with wire braid sheath. Ends shall be threaded, with union connectors, for pipe sizes 50 mm (2 inches) and below, flanged for pipe sizes 65 mm (2-1/2 inches) and greater.
- C. Units for Compressed Air Service Only:
1. Service: Designed for 93 degrees C (200 degrees F), 1025 kPa (150 psi), 13 mm (1/2-inch) intermittent offset.
  2. Construction. Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.
- D. Units for Atomizing Media Service(Steam, Compressed Air) and Steam Safety Valve Drip Pan Ell Drains:
1. Service: Designed for saturated steam at set pressure of boiler safety valves or for set pressure of compressor relief valve, whichever is greater. Hose shall be designed for bend radii to suit location of connection points to burner piping system. Hose shall also be designed for intermittent flexing.

2. Construction: Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

## 2.22 PIPING SUPPORT SYSTEMS

- A. Provide an engineered piping support system with all hangers, supports and anchors designed and located by experienced technical pipe support specialists, utilizing piping system design and analysis software. The system design must be completely documented and submitted for review.
- B. All pipe hangers and supports, and selection and installation shall comply with MSS SP-58, SP-69, SP-89, SP-90, SP-127.
- C. All pipe hanger and support devices must be in compliance with specified MSS SP-58 type numbers, have published load ratings, and be products of engineered pipe support manufacturers.
- D. All pipe stresses and forces and moments on connecting equipment and structures shall be within the allowances of the ASME B31.1 code, applicable building codes, and equipment manufacturer's design limits.
- E. Piping that expands and contracts horizontally including steam, steam condensate, boiler feed, condensate transfer, shall be supported by roller or sliding type hangers and supports except when long vertical hanger rods permit sufficient horizontal movement with the vertical angles of the rods less than 4 degrees.
- F. Piping that expands and contracts vertically including steam, steam condensate, boiler feed, condensate transfer, shall be supported by engineered variable spring and spring cushion hangers. Utilize MSS SP-69 selection requirements and guidelines. Vibration isolator hanger types are not permitted.
- G. Piping system anchors shall be engineered and located to control movement of piping that is subject to thermal expansion.
- H. Prior to construction, submit complete engineering calculation methods and results, descriptions of all devices with MSS numbers, sizes, load capabilities and locations. Submit calculations on all moments and forces at anchors and guides, all hanger loads, all pipe stresses that are within 20% of the code allowable or exceed the ASME B31.1 code allowable, all pipe movements at supports.
- I. Detailed Design Requirements:
  1. Piping system design and analysis software shall be current state of the art that performs B31.1 Code analyses, and shall be utilized to analyze pipe movement and deflection, pipe stresses, pipe support

forces and moments, and for selection of pipe support types and sizes.

2. Each support for piping 60 mm (2-1/2 inches) and above shall be completely engineered to include location, type and size, hot and cold loads and movement. Submit layout drawings showing precise support locations and submit individual drawings for each support assembly showing all components, sizes, loadings.
3. Supports for piping 50 mm (2 inches) and below shall be engineered in general terms with approximate locations, typical support types and sizes, approximate movements. Submit layout drawings showing general locations and support types and sizes.
4. Obtain permissible loadings (forces and moments) for equipment nozzles (pipe connections) from the manufacturer of the boilers, the feedwater deaerator and any other equipment as necessary. Professional structural engineer shall verify capability of building structure to handle piping loads.
5. The project drawings may show locations and types of resilient supports including rollers and springs, and may also show special supports including anchors, guides and braces. Comply with the drawing requirements unless it is determined that piping may be overstressed or supports overloaded. Refer conflicts to the PM/COTR.
6. Variable spring hangers conforming the MSS SP-58, Type 51, shall support all piping that expands vertically from thermal effects which may include connected equipment, such as boilers. Spring rates must be selected to avoid excessive load transfer to the connected equipment as the piping expands vertically. Vibration-type spring isolators are not acceptable. Light duty spring hangers, MSS SP-58, Type 48, may be utilized on loads of 90 kg (200 lb) or less, and vertical movement of 3 mm (0.125 inches) or less. Spring cushion hangers, MSS SP-58, Type 49, may be utilized for vertical movement of 3 mm (0.125 inches) or less.
7. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
8. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the Government.

J. Hangers and Supports - Products:



1. Factory-built products of a manufacturer specializing in engineered pipe supports. All components must have published load ratings. All spring type supports shall have published spring rates and movement limits. All support assemblies shall include threaded connections that permit vertical position adjustment. Supports shall comply with MSS SP-58 Type Numbers as listed below.
2. Upper Attachments to Building Structure: Types 18, 20, 21, 22, 23, 29 and 30.
3. Roller Supports: Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
4. Variable Spring Hanger Assembly:
  - a. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
  - b. Typical features of variable spring hangers include spring rates under 150 lb/in, enclosed spring, load and travel indicator, sizes available with load capabilities ranging from 50 lb to multiples of 10,000 lb.
5. Spring Cushion Hanger Assembly: Double Rod: Type 41 and 49.
6. Light Duty Spring Hanger Assembly: Type 48 light duty spring, with Type 3 pipe clamp or Type 1 clevis. Locate Type 48 light duty spring within 300 mm (1 foot) above pipe attachment.
7. Clevis Hangers: Type 1.
8. Wall Brackets: Type 31, 32 and 33.
9. Pipe Stands: Type 38.
10. Riser Clamps: Type 42.
11. Roller Guides: Type 44. Construct guides to restrain movement perpendicular to the long axis of the piping. All members shall be welded steel.
12. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with U-bolts.
13. Pipe Covering Protection Saddles: Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided. Insulation shields are not permitted. Refer to Section 23 07 11, HVAC and BOILER PLANT INSULATION.

14. Sliding Supports: Type 35. Welded steel attachments to pipe and building structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
15. Piping Anchors: Provide engineered designs to accommodate the calculated loads.

#### **2.23 PIPE AND VALVE FLANGE GASKETS**

Non-asbestos, designed for the service conditions. On steam service utilize 3 mm (1/8 inch) thick Class 300 spiral-wound with Type 304 stainless steel and mica/graphite filler and carbon steel gauge ring.

#### **2.24 THREAD SEALANTS:**

As recommended by the sealant manufacturer for the service.

#### **2.25 PIPE SLEEVES:**

- A. Service: For pipes passing through floors, walls, partitions.
- B. Construction: Steel pipe, schedule 10 minimum.
- C. Sleeve Diameter: Not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe and thermal insulation, vapor barrier, and protective covering for insulated pipe; sleeves for un-insulated pipe shall be not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe.

### **PART 3 - EXECUTION**

#### **3.1 ARRANGEMENT OF PIPING**

- A. The piping arrangement shown is a design based on currently available equipment. The plans show typical equipment to scale and show practical arrangement. Modification will be necessary during construction, at no additional cost to the Government, to adapt the equipment layout and piping plans to the precise equipment purchased by the Contractor. Accessibility for operation and maintenance must be maintained.
- B. All piping shall be installed parallel to walls and column centerlines (unless shown otherwise). Fully coordinate work of each trade to provide the designed systems without interference between systems. All piping shall be accurately cut, true, and beveled for welding. Threaded piping shall be accurately cut, reamed and threaded with sharp dies. Copper piping work shall be performed in accordance with best practices requiring accurately cut clean joints and soldering in accordance with the recommended practices for the material and solder employed.
- C. All piping shall be pitched for drainage at a constant slope of 25 mm in 12 m (1 inch in 40 feet). Steam, condensate, trap discharge, drip,

drain, air, gas and blowdown piping shall pitch down in direction of flow. Service water, pumped condensate, pumped boiler feedwater, oil, shall pitch up in direction of flow. Provide valved air vents at top of rise and valved drains at low points. Gas piping may be run level as it is presumed to be dry, but dirt pockets shall be provided at base of risers.

- D. Valves shall be located and stems oriented to permit proper and easy operation and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be below centerline of pipe. Refer to plans for stem orientation. Where valves are more than 2100 mm (7 feet) above the floor or platform, stems shall be horizontal unless shown otherwise. Gate and globe valves more than 3 m (10 feet) above floor or platform, shall have chain wheel and chain for operation from floor or platform. Provide hammer-blow wheel on any valve that cannot be opened or tightly closed by one person. Steam line gate and butterfly type isolation valves 750 mm (3 inch) pipe size and above shall have factory or field-fabricated 20 mm or 25 mm (3/4 or one inch) globe-valved warm-up bypasses if the steam line length is 6 m (20 feet) or longer.
- E. Provide union adjacent to all threaded end valves.
- F. Bolt wafer-type butterfly valves between pipe flanges.
- G. Provide valves as necessary to permit maintenance of a device or sub-system without discontinuing service to other elements of that service or system.
- H. Do not install any piping within 600 mm (2 feet) of water tube boiler side or top casings.

### **3.2 WELDING**

- A. The contractor is entirely responsible for the quality of the welding and shall:
  - 1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
  - 2. Comply with ASME B31.1 and AWS B2.1.
  - 3. Perform all welding operations required for construction and installation of the piping systems.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform to

the applicable portions of ASME B31.1, and AWS B2.1, and also as outlined below.

- C. Examining Welder: Examine each welder at job site, in the presence of the PM/COTR, to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the RE with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Utilize split welding rings or approved alternate method for joints on all pipes above 50 mm (two-inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (one foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).
- H. Non-Destructive Examination of Piping Welds:
  - 1. The RE may require up to ten percent of the welded piping joints to be examined using radiographic testing. If defective welds are discovered the RE may require examination of all pipe joint welds.
  - 2. An approved independent testing firm regularly engaged in radiographic testing shall perform the radiographic examination of pipe joint welds. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.
  - 3. Comply with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and

a location plan showing the physical location where each weld is to be found in the completed project. The PM/COTR reserves the right to review all inspection records.

- I. Defective Welds: Replace and re-inspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be re-qualified.
- J. Electrodes: Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

### **3.3 PIPING JOINTS**

- A. All butt-welded piping shall be welded at circumferential joints, flanges shall be weld neck type; slip-on flanges, screwed flanges may be applied only with written approval of the RE.
- B. Companion flanges at equipment or valves shall match flange construction of equipment or valve. Raised face shall be removed at all companion flanges when attached to flanges equipped for flat face construction.
- C. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.
- D. Screw threads shall be made up with Teflon tape except gas and oil piping joints shall utilize specified joint compound.
- E. Solder joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

### **3.4 BRANCH INTERSECTION CONNECTIONS**

- A. Factory-built reinforced tees and laterals are required.
- B. Factory-built integrally reinforced forged steel branch outlet fittings may be used on reduced size connections upon approval of RE. They must comply with MSS-SP-97.

### **3.5 EXPANSION AND FLEXIBILITY**

The design includes provision for piping expansion due to pressure, thermal, weight and seismic (where applicable) effects. It is the Contractor's responsibility to avoid reduction in flexibility and increase in stress in piping systems. Major deviation will be shown by submittal for review of scale working drawings and stress calculations

for the piping systems. Contractor shall provide any necessary additional construction and materials to limit stresses to safe values as directed by the RE and at no additional cost to the Government.

### 3.6 PIPE BENDING

Pipe bending shall be in accordance with the recommended practices of PFI ES24. Only ASTM A106 seamless pipe may be bent. Sizes below 50 mm (2 inches) may be bent in field; sizes 65 mm (2-1/2 inches) and larger shall have factory fabricated bends. Minimum radii and tangent lengths for field bent piping are shown in the following table:

| Size         | Minimum Radius | Minimum Tangent |
|--------------|----------------|-----------------|
| 1/2 inch     | 2-1/2 inches   | 1-1/2 inches    |
| 3/4 inch     | 2-3/4 inches   | 1-3/4 inches    |
| 1-inch       | 5-inches       | 2-inches        |
| 1-1/4 inches | 6-1/4 inches   | 2-inches        |
| 1-1/2 inches | 7-1/2 inches   | 2-1/2 inches    |

### 3.7 SIZE CHANGES

Piping size changes shall be accomplished by use of line reducers, reducing ell, reducing tee. Apply eccentric reduction in all piping requiring continuous drainage; steam, condensate, vacuum, blowdown. Concentric reduction may be applied in run of piping involving pressure water systems except at pump inlets. Use concentric increasers where flow is in direction of increased size. Eccentric reduction, top flat, at all pump connections.

### 3.8 ADDITIONAL DRIPS AND TRAPS

Where additional rises or drops in steam or gas lines are provided, provide additional drip pockets with steam trap assemblies on steam lines and additional dirt pockets on gas lines.

### 3.9 MINOR PIPING

Minor piping associated with instrumentation and control is generally not shown. Interconnection of sensors, transducers, control devices, instrumentation panels, combustion control panel, burner control panels is the responsibility of the contractor. Small piping associated with water cooling, drips, drains and other minor piping may not be shown to avoid confusion in the plan presentation but shall be provided as part of contract work.

### 3.10 DIELECTRIC CONNECTION

Where copper piping is connected to steel piping provide dielectric connections.

### 3.11 INSTALLATION - BOILER EXTERNAL STEAM PIPING FROM BOILER TO MAIN HEADER

- A. From Boiler to Second Stop Valve: Fabricate from boiler nozzle through second stop valve under the rules for boiler external piping of the ASME Boiler and Pressure Vessel Code, Section I. Full compliance will be required, including qualification of welders, Code inspection, and certification with ASME Form P4A. Deliver original of Form P4A properly executed to RE.
- B. Construction shall include: non-return stop and check valve at the boiler, welding coupling for 20 mm (3/4-inch) vent, second stop valve, steam flowmeter primary element, welding coupling for IPT calorimeter connection located to provide clear space and access for temporary test calorimeter, and header stop valve. Second stop valve may be deleted if the entire steam line from the non-return valve to the header valve is constructed in accordance with the rules for boiler external piping, ASME Section I.
- C. Companion flange at 2050 kPa (300 psi) valves shall be 2050 kPa (300 psi) weld neck; at 1025 kPa (150 psi) valves shall be 1025 kPa (150 psi) weld neck.
- D. Equip header stop valve with factory applied warm-up bypass connected to drilled and tapped bosses in valve body located above and below valve wedge. Connect valved drain to header valve body boss located above valve wedge.
- E. Equip steam pipe with 20 mm (3/4-inch) vent, 1375 kPa (200 psi) bronze gate valve, as specified.
- F. Support and slope boiler steam line to drain; apply variable spring hangers (MSS-SP58, Type 51 or 53).
- G. Provide screwed fitting for calorimeter (temporary test instrument) on side of pipe as shown. Allow 600 mm (2 feet) horizontal and vertical clearance for calorimeter.
- H. Handwheel and drain valve on non-return stop-check valve shall be within easy reach of boiler platform.
- I. Disassemble, clean and reassemble entire mechanism of non-return stop check valve after conclusion of boiler testing.

**3.12 INSTALLATION - BOILER BOTTOM BLOWOFF PIPING**

Fabricate with long radius ells, Y-form laterals. Tees and crosses are not permitted.

**3.13 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF**

Provide drain line from connection on exhaust head to roof drain.

Provide pipe size same as drain connection size.

**3.14 INSTALLATION - SIGHT FLOW INDICATORS**

Locate to permit view from floor or platform.

**3.15 INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES**

Provide sufficient clearance on all sides of valve to permit replacement of working parts without removing valve from pipeline.

**3.16 INSTALLATION - FLEXIBLE CONNECTORS**

Install units for water and compressed air service in a straight run of pipe. Units for atomizing media service may be installed with bends if necessary. Designer of atomizing media piping must coordinate hose connection points with allowable bend radius of hose.

**3.17 INSTALLATION - SAFETY VALVES, RELIEF VALVES AND SAFETY-RELIEF VALVES**

- A. Orient valves so that lifting levers are accessible from nearest walkway or access platform. Valves must be removable without requiring disassembling of vents, except where otherwise specifically provided.
- B. Provide a drip pan elbow at discharge of each steam or economizer valve with slip joint in vent discharge line, arranged to prevent vent line from imposing any force on valve and to prevent any moisture accumulation in valve. Connected drip pan ell drains to drain piping to floor drain. Provide flexible connector on drain line, adjacent to drip pan ell.
- C. Support vent line from above. Each steam valve must have separate vent line to atmosphere unless shown otherwise.

**3.18 INSTALLATION - QUICK COUPLE HOSE CONNECTORS**

Install male plugs on each piping drain. Connect socket to one end of steam hose.

**3.19 INSTALLATION - VIBRATION ISOLATORS IN PIPING**

- A. Install on all air lines and water supply lines to air compressors.
- B. Also install on pump connections as shown.



**3.20 INSTALLATION - PIPE SLEEVES**

- A. Accurately locate and securely fasten sleeves to forms before concrete is poured; install in walls or partitions during the construction of the walls.
- B. Sleeve ends shall be flush with finished faces of walls and partitions.
- C. Pipe sleeves passing through floors shall project 25 mm (1 inch) minimum above the finished floor surface and the bottom of the sleeve shall be flush with the underside of the floor slab.

**3.21 INSTALLATION - PIPE SUPPORT SYSTEMS**

- A. Coordinate support locations with building structure prior to erection of piping. Also refer to approved shop drawings of equipment and approved piping layout and hanger layout drawings when locating hangers. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site.
- B. Upper attachments to Building Structure:
  - 1. New Reinforced Concrete Construction: Concrete inserts.
  - 2. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles (or other construction shown on the drawings) which are expansion-bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
  - 3. Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.
- C. Expansion Fasteners and Power Set Fasteners: In existing concrete floor, ceiling and wall construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D. Special Supports:
  - 1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
  - 2. Where hangers cannot be adequately secured as specified, (for example, support for flow metering sensing lines, pneumatic tubing, control piping) special provisions shall be made for hanging and supporting pipe as directed by the RE.

3. Pipe supports, hangers, clamps or anchors shall not be attached to equipment unless specifically permitted by the specifications for that equipment or unless RE gives written permission. No attachments to boiler casings permitted.

E. Spring Hangers: Locate spring units within one foot of the pipe, breeching or stack attachment except in locations where spring assemblies interfere with pipe insulation. Adjust springs to loads calculated by hanger manufacturer.

### **3.22 CLEANING OF PIPING AFTER INSTALLATION**

Flush all piping sufficiently to remove all dirt and debris. Fill piping completely. Velocity shall be equivalent to that experienced during normal plant operation at maximum loads. During flushing, all control valves, steam traps and pumps must be disconnected from the system. After cleaning is complete, remove, clean and replace all strainer baskets and elements. Reconnect all equipment. Provide safe points of discharge for debris blown from pipes.

### **3.23 TESTING**

- A. Testing of piping components is not required prior to installation. Valves and fittings shall be capable of withstanding hydrostatic shell test equal to twice the primary design service pressure except as modified by specifications on fittings, ASME B16.5. This test capability is a statement of quality of material. Tests of individual items of pipe, fittings or equipment will be required only on instruction of RE and at Government cost.
- B. After erection, all piping systems shall be capable of withstanding a hydrostatic test pressure of 1.5 times design pressure, as stipulated in ASME B31.1. Hydrostatic tests will be required only on boiler external steam piping, utilizing water as the test medium. Hydrostatic tests will be required on other piping when operating tests described are unsatisfactory, or when inspection of welds shows poor workmanship and is subject to question by the RE. When hydrostatic tests show leaks, the RE will require necessary welding repairs, in accordance with ASME B31.1, at the Contractor's cost.
- C. Perform operating test as follows:
1. All steam piping prior to insulation shall be subjected to steam at final operating pressure. Inspect all joints for leaks and workmanship. Corrections shall be made as specified.

2. Test main gas piping with compressed air at twice the service pressure entering VA property from utility service. Test LP gas piping at the maximum tank pressure, 1725 kPa (250 psig), with compressed air. Test joints with soap solution, check thoroughly for leaks.
  3. Test boiler feedwater, condensate, vacuum and service water systems under service conditions and prove tight.
  4. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.
  5. Make corrections and retests to establish systems that have no leaks. Replace or recut any defective fittings or defective threads. Soldered material shall be thoroughly cleaned prior to resoldering. Back welding of threads will not be permitted.
- D. Hydrostatically test boiler external steam piping from boiler to header in approved manner with water of same time boiler is hydrostatically tested under the supervision of RE. Prior to hydrostatic test, remove all valves not rated for hydrostatic test pressure. Replace valves after tests are satisfactorily completed. Hydrostatic test pressure shall be 1.5 times design pressure and performed in accordance with ASME Boiler and Pressure Vessel Code, Section I.
- E. Generally, insulation work should not be performed prior to testing of piping. Contractor may, at own option and hazard, insulate piping prior to test, but any damaged insulation shall be replaced with new quality as specified for original installation at Contractor's cost and time.
- F. Safety, Safety-Relief, Relief Valves: After installation, test under pressure in presence of RE. Test operation, including set pressure, flow, and blowdown in accordance with ASME Boiler and Pressure Vessel Code. Any deficiencies must be corrected and retest performed. Refer to Section 23 52 33.20, Heat Recovery Steam Generator (HRSG) for boiler safety valve test requirements.

### **3.24 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 -

COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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