

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

### **PART 1 GENERAL**

#### **1.01 DESCRIPTION**

- A. 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.

#### **1.02 RELATED WORK**

- A. Section 23 07 11 – HVAC and Boiler Plant Insulation.

#### **1.03 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.

#### **1.04 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. 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.

#### **1.05 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. 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.

#### 1.06 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 are designed and materials and equipment are applied to prevent failure under gas pressure of 100 kPa (15 psi) entering Government property. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 1725 kPa (250 psig).
- F. Fuel oil system pressures are determined by the requirements of the burners and fuel trains. No. 2 oil systems are designed for maximum temperatures of 55 degrees C (130 degrees F), and pressures of 1025 kPa (150 psi).
- G. Water service pressures are 545 kPa (80 psi) maximum. Systems are designed to operate under conditions of maximum available pressure.
- H. 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.
- I. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psi) saturated steam.
- J. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).
- K. Instrumentation and control piping shall be provided for the service and pressure characteristics of the systems to which they are connected.

## 1.07 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):
  - 1. A47/A47M-99(2009): Standard Specification for Ferritic Malleable Iron Castings
  - 2. A48/A48M-03(2008): Standard Specification for Gray Iron Castings
  - 3. A53/A53M-07: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  - 4. A105/A105M-10: Standard Specification for Carbon Steel Forgings for Piping Applications
  - 5. A106/A106M-08: Standard Specification for Seamless Carbon Steel Pipe For High Temperature Service
  - 6. A126-04(2009): Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
  - 7. A193/A193M-10a: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
  - 8. A194/A194M-10: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
  - 9. A197/A197M-00(2006): Standard Specification for Cupola Malleable Iron
  - 10. A216/A216M-08: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High Temperature Service
  - 11. A234/A234M-10: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
  - 12. A269-10: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  - 13. A395/A395M-99(20049): Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for use at Elevated Temperatures
  - 14. A536-84(20049): Standard Specification for Ductile Iron Castings
  - 15. B61-08: Standard Specification for Steam or Valve Bronze Castings
  - 16. B62-09: Standard Specification for Composition Bronze or Ounce Metal Castings
  - 17. B88/B88M-09: Standard Specification for Seamless Copper Water Tube
- C. American Society of Mechanical Engineers (ASME):
  - 1. Boiler and Pressure Vessel Code: 2010 Edition with current Addenda
  - 2. Section I: Power Boilers

3. Section IX: Welding and Brazing Qualifications
  4. B16.3-2006: Malleable Iron Threaded Fittings
  5. B16.4-2006: Gray Iron Threaded Fittings
  6. B16.5-2009: Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24
  7. B16.9-2007: Factory Made Wrought Buttwelding Fittings
  8. B16.11-2009: Forged Fittings, Socket-Welding and Threaded
  9. B16.22-2001: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  10. B31.1-2010: Power Piping
- D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
1. SP-45-2003: Bypass and Drain Connections
  2. SP-58-2009: Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application, and Installation
  3. SP-69-2003: Pipe Hangers and Supports – Selection and Application
  4. SP-80-2008: Bronze, Gate, Globe, Angle and Check Valves
  5. SP-89-2003: Pipe Hangers and Supports-Fabrication and Installation Practices
  6. SP-90-2000: Guidelines on Terminology for Pipe Hangers and Supports
  7. SP-97-2006: Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded and Buttwelding Ends
  8. SP-127-2001: Bracing for Piping Systems Seismic – Wind – Dynamic Design, Selection, Application
- E. National Fire Protection Association (NFPA):
1. 30-2008: Flammable and Combustible Liquids Code
  2. 31-2011: Standard for the Installation of Oil Burning Equipment
- F. American Welding Society (AWS):
1. B2.1-052009: Specification for Welding Procedure and Performance Qualification
- G. Pipe Fabrication Institute (PFI):
1. ES24-R08: Pipe Bending Methods, Tolerances, Process and Material Requirements
- H. U.S. Department of Veterans Affairs (VA):
1. VHA Boiler Plant Safety Device Testing Manual.

## **PART 2        PRODUCTS**

### **2.01     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.

### **2.02     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).

## 2.03 DIELECTRIC FITTINGS

- A. 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.

## 2.04 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 SP045, MSS SP080, 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.
- C. 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.

## 2.05 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 percent 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/COR.
  - 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.

K. 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.

## 2.06 PIPE AND VALVE FLANGE GASKETS

- A. 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.

## PART 3 EXECUTION

### 3.01 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 subsystem 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.

### 3.02 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 Project Manager (PM), 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 PM 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 PM may require up to ten percent of the welded piping joints to be examined using radiographic testing. If defective welds are discovered the PM 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/COR reserves the right to review all inspection records.
- I. Defective Welds: Replace and reinspect 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 requalified.
- 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.

### 3.03 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 PM.
- 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.

### 3.04 SIZE CHANGES

- A. 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.

### 3.05 DIELECTRIC CONNECTION

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

### 3.06 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 PM.
  - 3. Pipe supports, hangers, clamps or anchors shall not be attached to equipment unless specifically permitted by the specifications for that equipment or unless PM 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.

### 3.07 CLEANING OF PIPING AFTER INSTALLATION

- A. 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.

### 3.08 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 PM 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 PM. When hydrostatic tests show leaks, the PM 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. 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. 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.

**END OF SECTION**