TABLE OF CONTENTS

1. GENERAL 2
1.1 Scope 2
1.2 References 2
1.3 Service Definitions 3
2. DESIGN REQUIREMENTS 4
2.1 General 4
2.2 Mechanical Loadings 4
2.3 Piping Components 5
a. Flanges 5
b. Valves 6
c. Strainers 7
d. Pressure Relief Valve Piping 9
e. Vents, Drains, and Sample Connections 9
f. Instrument Piping 10
g. Underground Piping 11
h. Utility Piping 12
i. Miscellaneous 12
2.4 Special Considerations 13
3. MATERIALS 13
3.1 General 13
3.2 Requirements Applicable to 1Cr-½ Mo, 1¼Cr-½ Mo and 2¼ Cr- 1Mo Materials 14
3.3 Additional Requirements Applicable to 1 Cr-1/2 Mo and 1 1/4 Cr-1/2 Mo Materials for Services with Operating Temperatures Over 825°F (440°C) 14
3.4 Additional Requirements Applicable to Longitudinally Electric Fusion Welded Pipe from 2¼Cr-1Mo Materials for Services with Operating Temperatures Over 650°F (345°C) 14
3.5 Gaskets 16
3.6 Pipe Supports 16
4. FABRICATION 17
4.1 General 17
4.2 Heat Treatment 17
5. NONDESTRUCTIVE EXAMINATION 18
5.1 General 18
5.2 Butt Welds 18
5.3 Socket Welds 19
6. PRESSURE TESTING 19
6.1 Testing Medium and Conditions 19
6.2 Procedure 20

1. GENERAL

1.1 Scope

a. This Standard Specification covers the design requirements, materials, fabrication, inspection, and testing of piping and piping components. The detail design of the piping system shall be the responsibility of the Owner/Contractor, consistent with the requirements of UOP Project Specifications.

b. Exceptions or variations shown in the UOP Project Specifications take precedence over requirements shown herein.

1.2 References

Unless noted below, use the edition and addenda of each referenced document current on the date of this UOP Standard Specification. When a referenced document incorporates another document, use the edition of that document required by the referenced document.

a. American Society of Mechanical Engineers (ASME) B31.3, “Process Piping”

b. ASME B46.1, “Surface Texture (Surface Roughness, Waviness, and Lay)”

c. ASME B16.5, “Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24”

d. ASME B16.47, “Large Diameter Steel Flanges NPS, 26 Through NPS 60”

e. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

f. United States (U.S.) Environment Protection Agency (EPA) Regulations 40 CFR Parts 60, 61, 63, and 280

g. American Petroleum Institute (API) RP520, “Part I-Sizing and Selection and Part II-Installation”

h. American Petroleum Institute (API) RP521, “Guide for Pressure-Relieving and Depressuring Systems”

i. International Organization for Standardization (ISO) ISO 5167-1, “Measurement of Fluid Flow by means of Pressure Differential Devices”

j. ASME MFC-14M, “Measurement of Fluid Flow Using Small Bore Precision Orifice Meters”

k. National Association of Corrosion Engineers (NACE) International Standard RP0169, “Control of External Corrosion on Underground or Submerged Metallic Piping Systems”

l. ASME Boiler and Pressure Vessel Code, Section I, “Rules for the Construction of Power Boilers”

m. ASME B16.20, "Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed"

n. American Society for Testing and Materials (ASTM),A 36," Standard Specification for Carbon Structural Steel"

o. American Society for Testing and Materials (ASTM), A992, "Standard Specification for Structural Shapes for Use in Building Framing"

p. ASTM A240, "Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels"

q. ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination

r. National, state, and local governmental regulations and laws

1.3 Service Definitions

a. Hydrogen Service

Hydrogen service is defined as a process stream with a hydrogen partial pressure of 100 psia [7.0 kg/cm^2 (a)] or greater, or service containing 90% hydrogen or higher at any pressure level.

b. Hydrogen Sulfide (H_2S) Service

H_2S service is defined as a process stream containing either of the following:

(1) H_2S in a concentration greater than 0.3 mole percent with an aqueous phase

(2) Where liquid water is present containing greater than 10 ppm of H_2S

c. Hydrofluoric Acid (HF) Service

HF service is defined as a process stream containing any concentration of HF acid.

d. Amine Service

Amine service is defined as monoethanolamine (MEA), diethanolamine (DEA), and other amines in solutions of greater than 2 weight percent.

e. Toxic Service

Toxic service is defined as Category M Fluid Service per ASME B31.3, Paragraph 300.2.

f. Severe Cyclic Service

Severe cyclic service is defined as the conditions of the piping system per ASME B31.3 Paragraph 300.2.

2. DESIGN REQUIREMENTS

2.1 General

a. The design, materials, fabrication, inspection and testing of piping shall be in accordance with ASME B31.3.

b. In addition to the requirements in 2.1a. above, the minimum wall thickness for new pipes, excluding corrosion allowance and negative mill tolerance, shall be Schedule 5S.

c. Contractor shall be responsible for the inclusion of the sustained, transient and thermal load analyses cases.

d. Contractor shall be responsible for the compatibility of piping flanges mating with equipment and instruments.

e. For vacuum design, the minimum differential external pressure shall be 15 psi (1.05 kg/cm2).

f. The design minimum temperature shall be as minimum design metal temperature (MDMT) for the connecting equipment shown on the UOP Material Selection Diagrams (MSD's).

g. Applicable UOP Pipe Classes where applied, are shown on the UOP Piping and Instruments Diagrams (P&ID's)

2.2 Mechanical Loadings

a. Wind and earthquake loads shall be determined in accordance with the governing Code(s), standard(s) and the data specified in the UOP Project Specifications.

b. Pipe supports shall be capable of supporting pipe full of water at ambient temperature.

c. Where free draining requirements are specified they shall be met under all conditions, taking into account piping deflections.

d. Stress, deflection, and fatigue shall be evaluated for the applicable loading conditions including thermal expansion. Piping reactions at the equipment shall be within the allowable limits for the equipment.

e. The piping system evaluation shall include operating, start-up, shutdown, and steam out conditions.

f. The piping system shall be properly designed to avoid severe cyclic conditions.

g. Piping associated with compressors requires that the amplitude and the spectral frequency distribution of pulsation be accommodated.

h. Pipe supports shall be designed to withstand all loading combinations including any frictional forces due to the sliding of supports.

2.3 Piping Components

a. Flanges

(1) ASME Class 150 flanges shall not be used for process lines with design temperatures over 700ºF (370ºC).

(2) Slip-on flanges are not recommended for any service and are only permitted when all of the following conditions are met:

(a) The hydrogen partial pressure (design) does not exceed 100 psia [7.0 kg/cm2(a)].

(b) The fluid service is not corrosive to the material present.

(c) Post weld heat treatment is not performed.

(d) The flange is not in a severe cyclic service.

(e) The maximum design temperature does not exceed 500ºF (260ºC).

(f) Flanges are Class 150 maximum.

(g) Slip-on flanges, when permitted, shall be double welded and vented through the hub with 1/8 inch (3 mm) diameter pre-drilled vent holes.

(3) Slip-on flanges are not permitted in orifice flange services.

(4) Lap joint flanges shall not be used in severe cyclic services.

(5) Flanges intended for use with spiral wound gaskets shall have a flange surface finish of 125 microinch Ra minimum to 250 microinch Ra maximum. Flanges intended for use with other gaskets shall have a flange surface finish within the optimal range for the specified gasket. Finishes shall be judged by visual comparison with surface finish roughness standards in accordance with ASME B46.1. Flange finishes shall be protected from damage during fabrication, heat treatment, shipping, storage, and installation.

(6) Ring joint flanges shall have a flat bottom groove with the intersection between the bottom and the sides of the groove machined to a smooth 0.125 inch (3 mm) minimum radius.

(7) Flanges and bolts shall be analyzed to insure that they are not overstressed during gasket seating. Overstressing is more likely to occur when Class 300 and lower flanges are used with spiral wound or metal gaskets.

(8) Flange classes are specified in accordance with ASME B16.5 or ASME B16.47, Series B (Series A is required if connected directly to an item furnished with Series A flanges). Flange classes listed in the UOP Project Specifications are based upon design pressure and temperature conditions only, and do not account for other loads. The final design of flanges shall account for gasket seating and external loads. Differential thermal expansion of dissimilar metal joints and transient thermal conditions such as start-up/shutdown and operational upset shall be accommodated.

(9) Flanges outside the scope of ASME B16.5 or B16.47 shall be designed in accordance with ASME Section VIII, Division 1, Appendix 2 and Appendix S. Bolts and gasket materials for these flanges are specified in the UOP Pipe Classes.

(10) Welding neck orifice flanges shall be the same bore as the pipe to which they are attached and shall be aligned as accurately as possible. Welds shall be ground smooth inside the pipe.

(11) Flanged thermowells and other flanged connections joining dissimilar materials require special consideration. The flange class for both materials shall be determined and the higher class used for both flanges.

(12) Flat face flanges with full faced gaskets shall be used against flat face cast iron valves and equipment.

b. Valves

(1) Valves in piping containing at least five weight percent organic hazardous air pollutants (HAP) or ten weight percent volatile organic compounds (VOC) shall be located for ease of fugitive emission monitoring as required by environmental regulations. U.S. EPA Regulations 40 CFR Part 60 Subparts VV or GGG, Part 61 Subpart J, and Part 63 Subpart H are applicable.

(2) Block valves in branch piping at headers shall be located in horizontal runs at high points, such that fluids will drain away from the block valve in both directions.

(3) Locked open or car sealed open valves shall include metal tags permanently attached to the valve. The tag shall read: "This valve must not be closed without written permission from responsible authority". The stems of locked open or car sealed open valves shall be installed in horizontal position.

(4) Threaded control valves and pressure relief valves shall not be seal welded. Threaded flanges fitted to such valves shall be seal welded.

(5) Orientation of valve stems shall not be below horizontal plane.

(6) Valves shall be located for ease of operation and maintenance. Use of chain operated valves shall be minimized

(7) For steam service, provide warm-up bypasses around 4 inch and larger ASME Class 600 or higher valves.

(8) Gear or motor operated valves shall be provided as indicated on the UOP Piping and Instrument Diagrams (P&IDs). If none are indicated, gear operators as recommended by the manufacturer, shall be provided. Valves with chain or gear operators shall have an indicator to show if open or closed.

(9) A stainless steel tag stamped with valve tag number shall be permanently attached to each valve with corrosion resistant wire prior to shipment. Contractor shall be responsible that tags remain on the valves in a conspicuous location throughout construction and that they do not become hidden by insulation.

(10) The preferred location for swing check, tilting check, and dual plate wafer check valves is in the horizontal run of piping. Manufacturer's straight run requirements of pipe, upstream and downstream of the check valves from any obstruction such as other type of valves or fittings shall be met. When they are installed in the vertical run of pipe, the manufacturer's recommended practice for straight run requirements of pipe and spring torque design shall be followed. Manufacturer's recommended velocity criteria at valve ports shall be met.

c. Strainers

(1) General

(a) Strainers not specified in UOP Project Specification –806, "Strainers", shall be designed, fabricated, and inspected in accordance with ASME Section VIII, Division 1.

(b) Strainers shall be designed and fabricated to prevent damage due to vibration, differential pressure, pulsating flow, and impact of objects. Screens of mesh size 20 or finer shall be reinforced with perforated plates or heavier screen with steel bars.

(c) Permanent strainers shall be installed when depicted on UOP P&ID's.

(d) Orientation of the strainer element relative to process flow shall ensure that collected solids or foreign material shall not fall back into the line.

(e) The strainer body material shall be consistent with the applicable UOP Pipe Class(es).

(f) As a minimum, strainer internals shall be stainless steel.

(g) The design and location of permanent strainers shall permit cleaning without removing the strainer body.

(h) ASME Class 900 and greater cast strainer bodies and integral flanges in hydrogen service shall have a casting quality factor of 100 percent. The examination shall be performed by radiography in accordance with ASME Section VIII, Division 1, Appendix 7. For 2 inch and smaller strainer bodies, if radiography is not possible, a helium mass spectrometer test (probe technique) in accordance with ASME Section V, Subsection A, Article 10, Appendix V is acceptable. Casting repairs and identification shall meet the requirements of paragraph 7-4 and 7-5 of Appendix 7 of ASME Section VIII, Division 1.

(i) Inline Y-Type and T-Type strainers shall have a flanged clean out connection.

(2) Pump and Compressor Strainers

(a) In horizontal suction lines to pumps and compressors, the strainers shall be T-Type. In vertical suction lines, the strainer shall be either Y-Type or T-Type. For vertical suction lines, the screen tub for T-Type strainers shall be orientated per recommendations of the manufacturer.

(b) Strainers for centrifugal pump and centrifugal compressor suction lines shall be either a perforated plate with 5/32 inch (4mm) diameter holes, or 5 mesh screen with 62 percent open area . The effective area of the screen assembly shall not be less than 150 percent of the pipe cross sectional area. A temporary 40 mesh (400 micron), 0.01 inch (0.254mm) diameter wire overlay screen cloth shall be installed for start-up.

(c) Strainers for reciprocating compressor suction lines shall be either a perforated plate with 5/32 inch (4mm) diameter holes, or 5 mesh screen with 62 percent open area. The effective area of the screen assembly shall not be less than 150 percent of the pipe cross sectional area. A temporary 80 mesh (177 micron), 0.01 inch (0.254mm) diameter wire overlay screen cloth shall be installed for start-up.

(3) Temporary Strainers

When temporary strainers are used during line flushing and initial operation of new or revamped units the following shall apply:

(a) Piping layout shall permit the insertion and removal of the temporary strainers without disturbing equipment alignment. Pipe fittings such as Tee's,Y's or fabricated pipe spools are acceptable for this purpose.

(b) Temporary strainers shall be provided with identification tags that protrude from the pipe flanges.

(c) The effective area of the screen assembly shall not be less than 150 percent of the cross sectional area of the pipe.

(d) Temporary strainers shall be removed after flushing and start-up of the line.

(4) Basket Type Strainers

Basket type strainers shall meet the following requirements:

(a) The effective area of the screen assembly shall not be less than 250 percent of the pipe cross sectional area.

(b) Strainer bodies shall be provided with tapped NPT blow-off connections.

(c) Strainers shall be provided with bolted top covers for easy removal of strainer elements.

(d) Large capacity fabricated strainers shall be provided with their own floor mounting stands.

d. Pressure Relief Valve Piping

(1) Inlet piping shall be in accordance with API RP520, Part II.

(2) Discharge piping shall be in accordance with API RP520, Parts I & II and API RP521. The nominal diameter of the discharge piping shall be no less than the diameter of the outlet flange.

(3) When the relief valve discharge is to a closed relief system, discharge piping shall be self-draining from the relief valve to the relief header. When this is not practical, discharge piping shall self drain to a liquid knock out (KO) drum to prevent accumulation of liquid.

(4) Atmospheric discharge from vents and relief or safety valves shall be located at least 10 feet (3 meters) above any platform within a 25 feet (7.5 meters) radius. This is not applicable for small cooling water thermal relief valves. Discharge from these valves shall be located to avoid any hazards such as freezing on walkways or platforms.

(5) Relief valves discharging to atmosphere can develop large jet reactive forces. The discharge lines shall be adequately supported and braced to avoid excessive vibrations or stresses in the valves or piping.

e. Vents, Drains, and Sample Connections

(1) Piping shall be designed to avoid liquid and gas traps. Where gas traps are unavoidable, they shall have plugged valve vents. Where liquid traps are unavoidable, they shall have plugged valve drains. Plugs for vents and drains shall be in accordance with Section 2.3 i. (6).

(2) Valves at low point drains and high point vents shall be welded on the process side and threaded and plugged on the vent or drain side.

(3) High point vents without valves shall have threaded fittings with plugs. Plugs in welded piping shall be seal welded after completion of field pressure testing.

(4) Valves in vent and drain piping shall have the same trim as valves in the process piping.

(5) Sample connections shall be located at or above the horizontal plane.

(6) Drains shall be provided upstream of the valves where water or condensate may collect.

(7) Sample piping shall be as short as possible and adequately braced to protect it from damage when valves are operated.

f. Instrument Piping

(1) Instrument piping shall be Schedule 80 minimum.

(2) Instrument piping connecting to alloy piping shall be the same alloy through the first block valve with the same valve trim. The remainder of the instrument piping shall be suitable for the process conditions. Valve material and valve trims shall be the same as for the process lines.

(3) For ASME Class 600 flange and lower, tubing is acceptable for instrument impulse lines downstream of the first block valve with the following limitations:

(a) Use Type 316 stainless steel annealed tubing for non-chloride containing services.

(b) Use carbon steel tubing for chloride containing services.

(4) Instrument impulse lines shall be hard-piped for services in flange ASME Class 900 or higher.

(5) The main instrument air supply header shall be 1 1/2 inch minimum size. Instrument air piping shall be galvanized inside and outside.

(6) Accessibility

(a) Provide access to flow meter runs and flow meters from a platform, portable stairs, or temporary ladder for servicing without increasing impulse line lengths.

(b) Control valves, pressure relief valves, and level transmitters shall be accessible from grade or a permanent platform.

(c) Pressure gauges, pressure transmitters, temperature instruments, and gauge glasses shall be accessible from grade, platforms, or ladders.

(7) For orifice taps and venturi taps in horizontal lines, the following shall apply

(a) For liquid, steam, or condensable vapor lines the taps shall be in the horizontal. Tap locations other than in the horizontal, such as 45° taps are not acceptable.

(b) For gas lines, the taps shall be in the vertical on the top or not more than 45° from the vertical on the top.

(8) Orifice meter run smoothness, out of round, etc. shall conform to the requirements of ISO 5167-1 or ASME MFC-14M.

(9) Threaded connections at instruments and instrument vent and drain piping shall not be seal welded.

(10) Orifice flange taps and plugs shall be made up dry and seal welded where socket

weld piping is specified.

(11) Valves at control valve manifolds shall be sized in accordance with the following (all sizes are nominal in inches)

Control Valve Size	Pipe Size	Block Valve Size	Bypass Valve Size
3/4	3/4	3/4	3/4
3/4	1	1	1
3/4	1 1/2	1 1/2	1
3/4	2,3,4	2	1
1	1	1	1
1	1 1/2	1 1/2	1 1/2
1	2,3,4	2	1 1/2
1 1/2	1 1/2	1 1/2	1 1/2
1 1/2	2,3,4	2	2
2	2	2	2
2	3,4,6	3	3
3	3	3	3
3	4,6,8	4	4
4	4	4	4
4	6,8	6	6
6	6	6	6
6	8,10	8	8
8	8	8	8
8	10,12	10	10
10	10	10	10
10	12,14	12	12
12	12	12	12
12	16	14	14

Where piping is expanded after a control valve assembly (e.g., flashing condition), the block valve downstream of the control valve shall be equal to, or one size smaller, than the expanded downstream piping.

g. Underground Piping

(1) Protection of underground or submerged metallic piping shall be in accordance with NACE International Standard RP0169.

(2) It shall be the responsibility of the Contractor to incorporate protective measures to minimize the potential for leakage of hazardous substances (e.g., hydrocarbons, solvents, desorbents) from any underground piping into groundwater, surface water or subsurface soils. Compliance with all applicable codes, standards and regulations is required. Underground piping shall be designed in accordance with U.S. EPA Regulation 40 CFR 280.

h. Utility Piping

(1) Service outlets (utility stations) for steam, air, and inert gas shall be provided as required.

(2) Header block valves shall be provided for each utility service.

(3) All utility branch lines shall be connected to the main as follows:

(a) At the top for vapor lines

(b) At the bottom for liquid lines

(4) All water and condensate piping around equipment shall be provided with necessary means to prevent freezing.

i. Miscellaneous

(1) Integrally reinforced fittings for branch connections shall be used wherever possible. Pipe to pipe connections, if used, shall be in accordance with ASME B31.3.

(2) External reinforcing pads shall have a minimum of one 1/4 inch vent hole. Pads for branch connections greater than 16 inch shall have a minimum of 2 vent holes. Pads installed in sections shall have at least one vent per section. Vents shall remain open until the completion of pressure testing. Plug material shall be adequate for the operating temperature but shall not be capable of sustaining pressure between the reinforcing plate and the pipe.

(3) Threaded unions are permitted only for utility services such as air, water, nitrogen, and steam condensate. Unions shall be limited to ASME Class 300. Flanges shall be used in place of unions for socket welded piping.

(4) An anti-seize sealant compound shall be applied to threaded connections. Teflon tape is an acceptable alternate for temperatures up to 400°F (205°C).

(5) Where seal welding of threaded connections is required, the use of anti-seize sealant is prohibited. Threaded connections shall be made up dry.

(6) Plugs shall be 3/4 inch minimum size and fabricated from solid bar stock (round or hexagonal) of compatible material as the valve or fitting. Plugs shall be visible after insulation is installed.

(7) Except for orifice taps, branch connections to process piping shall be 1 inch minimum. At orifice taps, the connection size shall be equal to the tap size.

(8) Piping layout and supporting arrangements shall accommodate vibrations caused by the process flow directional changes, attached equipment, and/or other sources.

2.4 Special Considerations

a. For operating temperatures 800°F (427°C) and over, severe cyclic services, or toxic services, the attachment welds for branch connections, supports, and other attachments to piping shall be continuous, full penetration with a smooth weld profile, and free of high local stress concentrations. Fillet welds shall be ground to a smooth concave contour.

b. Areas where stagnated hydrogen may be incidentally heated due to start-up or shut-down condition (e.g. hydrogen quench lines with block valves, bypass lines around equipment) shall be vented.

c. Piping leaving the process battery limit valve(s) shall be designed for a blocked in condition downstream of the battery limit valve(s). Alternately, lock (or car seal) open all block valves between the last block valve in the process area and the outside battery limit equipment.

3. MATERIALS

3.1 General

a. Piping materials shall be in accordance with ASME B31.3 or, where applicable, ASME Section I.

b. Each pipe, forging, flange, valve and other product form shall be legibly stamped or stenciled showing the specification number, grade, and class. When metal stamping is used it shall be on the long edge of each component as it leaves the mill. Metal stamping on rolled surfaces shall be done with a “low stress” stamp. Markings shall be protected from erosion, wear, or other events that may render them unreadable.

c. Material used in the fabrication of piping and piping components shall be new.

d. Reinforcing pads shall be the same material as the pipe.

e. Material for external vacuum stiffening rings shall be the same material as the pipe when the design temperature is greater than 650°F (340°C). When the design temperature is 650°F (340°C) or less, the material may be carbon steel.

3.2 Requirements Applicable to 1Cr-½ Mo, 1¼Cr-½ Mo and 2¼ Cr- 1Mo Materials

a. The maximum room temperature tensile strength of all pressure retaining components and welds shall be 100,000 psi (7030 kg/cm2).

b. Fillet welds to pressure retaining components shall be ground to a smooth, concave contour.

c. Pressure retaining welds, whether shop or field, shall be 100% radiographed. Branch welds that cannot be radiographed shall be 100% ultrasonically examined.

d. Accelerated cooling from the austenitizing temperature is acceptable, where permitted by the applicable product form specification.

3.3 Additional Requirements Applicable to 1 Cr-1/2 Mo and 1 1/4 Cr-1/2 Mo Materials for Services with Operating Temperatures Over 825°F (440°C)

a. Charpy V-notch impact testing is required for all pressure retaining longitudinally fusion welded pipe, components and welds. Impact tests shall be conducted in accordance with the requirements of ASME B31.3, except that there shall be no exemptions from impact testing and the test temperature shall be the lower of the design minimum metal temperature and 0°F (-18°C). The test specimens shall be supplied in the same heat treated condition as the new pipe.

b. The product analysis content of tin and phosphorous for pressure retaining components and welding consumables shall be less than 0.015% and 0.012% respectively. The percentage limits are weight percent.

3.4 Additional Requirements Applicable to Longitudinally Electric Fusion Welded Pipe from 2¼Cr-1Mo Materials for Services with Operating Temperatures Over 650°F (345°C)

a. Certified chemical analyses including Ni, Cu, As, Sn, and Sb shall be provided for all components

b. Material shall have a "J" factor defined as $(Si + Mn) \times (P + Sn) \times 10^4$, less than or equal to 100, where the concentrations are in percent. In addition, the nickel (Ni) content shall be equal or less than 0.30% and Copper (Cu) content shall be equal or less then 0.20%. Concentrations are in weight percent.

c. Welding consumables shall be in accordance with the following:

(1) Mn and Si levels shall be maintained at the lowest possible levels consistent with good weldability.

(2) Each batch or heat of welding consumable and covered electrodes, including the wire flux combinations used in fabrication, shall be analyzed for P, Sn, Sb, and As. Analysis shall be performed on deposited weld metal. The Temper Embrittlement Factor, X-bar, shall be as follows:

$$\text{X-bar} = (10\,P + 4\,Sn + 5\,Sb + As) / 100 \leq 15 \text{ parts per million (PPM)}$$

Element concentrations are in parts per million.

d. Charpy V-notch impact testing is required for all pressure retaining longitudinally fusion welded pipe, components and welds. Impact tests shall be in accordance with the requirements of ASME B31.3, except that there shall be no exemptions from impact testing and the test temperature shall be the lower of the design minimum temperature and -20°F (-29°C) and the average impact values of the three specimens shall not be less than 40ft-lbs (54 Joules) with no single value below 34 ft-lb (47 Joules). The test specimens shall be supplied in the same heat treated condition as the new pipe.

e. Impact energy versus temperature (transition) curves shall be developed for each heat of plate, pipe and weldments representing each batch or heat of welding consumable, covered electrodes, and wire flux combinations for each welding process used in production welds.

(1) A minimum of eight sets of three impact tests (of material subjected to the same heat treatment as the completed item) shall be conducted for each curve. Sample locations shall be as specified in ASME Section VIII, Division 1.

(2) The eight sets of impact tests shall be performed at different temperatures, but shall include the impact test temperature from Section 3.4d. above. The remaining test temperatures shall be selected so that the generated transition curve shall clearly define the transition zone and upper shelf. The maximum test temperature shall correspond to the upper shelf energy level.

f. The impact tests shall be performed at different temperatures, but shall include the impact test temperature specified for the piping and -20 ºF (-29 ºC). The remaining test temperatures shall be selected so that the generated transition curve clearly defines the transition zone and the upper and lower shelf. The maximum test temperature shall be on the upper shelf energy level (defined as 100 percent shear fracture) and the minimum test temperature shall be on the lower shelf energy level (defined as zero percent shear fracture). The upper and lower shelves shall each be defined by at least two test points, with at least four additional points defining the transition curve.

g. Step Cool Tests shall be performed on a sample (subjected to the same heat treatment as the completed item) from each heat of plate, pipe and weldments representing each batch or heat of welding consumable, covered electrodes, and wire flux combinations for each welding process used in production welds.

(1) Step cooling shall be in accordance with the following temperatures, holding times, cooling rates to the next lowest temperature

Temperature, °F (°C)	Holding Time, Hour	Cooling Rate to the Next Temperature,°F (°C) per Hour
1100 (595)	1	10 (6)
1000 (535)	15	10 (6)
975 (525)	24	10 (6)
925 (495)	60	5 (3)
875 (470)	100	50 (28)
600 (315)		air cool

(2) Impact tests of each Step Cool Test sample shall be performed and transition curves developed per the requirements of Section 3.4e.above.

(3) Acceptance criteria for the material shall be in accordance with the following:

$CvTr40 + 2.5\ \Delta CvTr40_{SC} \leq 50°F(10°C)$

Where

CvTr40 = Charpy V-notch 40 ft-lb (55 Joules) impact energy transition temperature of completely heat treated specimens before step cooling.

$\Delta CvTr40_{SC}$ = The shift in the Charpy V-notch 40 ft-lb (55 Joules) impact energy transition temperature after step cooling

3.5 Gaskets

a. Gaskets shall conform to the requirements of the UOP Pipe Class(es) specified on the UOP Piping and Instrument Diagrams.

b. Gaskets for raised face flanges shall be spiral-wound in accordance with ASME B16.20 with a non-asbestos filler material. The winding material shall be a minimum of Type 304 stainless steel. Gaskets shall include an outer retainer ring. The outer ring may be carbon steel, protected against corrosion. Gaskets for ASME Class 900 and greater flanges and flanges over 24 NPS in all flange classes shall have an inner retainer ring of the same material as the windings. The Contractor shall verify the adequacy of all gaskets considering potential buckling of the outer or inner retaining ring(s) and the windings.

c. Gaskets for ring type joint flanges shall be ring type of the compatible material to the flanges in accordance with ASME B16.20.

d. Gaskets for flat face flanges shall be 1/16” thick full face flexible graphite with 304 or 316SS corrugated insert, per ASME B16.21.

e. In order to obtain and maintain a proper seal joint for operating and hydrostatic test conditions, the gasket manufacturer recommendations for adequate bolt stress and sequence of bolt tightening shall be followed.

3.6 Pipe Supports

a. As a minimum pipe supports and other attachment materials shall be in accordance with ASTM A 36 or A 992.

b. Pipe support material selection shall be based on the operating temperature of the supported piping.

c. Pipe supports and restraints shall be designed to limit sag, maintaining the desired layout and slope.

d. Pipe supports and restraining system shall be capable of limiting the bending stresses and reactions on the equipment within the allowable range and avoid the excessive sway under operating and dynamic loading conditions.

4. FABRICATION

4.1 General

a. Pressure retaining butt welds shall be full penetration.

b. Circumferential butt weld joints shall be double-welded, where practical. In cases where double welding is impractical (e.g., the groove joint backside is not accessible for chipping or gauging and welding) the root pass shall be made by Gas Tungsten Arc Welding (GTAW) process.

c. Peening is not permitted.

d. After completion of welding from the first side of double butt welds, the initial root pass, including root tack welds, shall be chipped, ground, and gouged to sound metal. The back-chipped welds, welding groove, and plate edges shall be examined to insure that all cracks, laminations, pin holes, porosity, and other defects have been removed prior to commencing welding on the second side.

e. Root weld areas shall be examined before and after removal of defects.

f. The welds for branch connections shall be made clear of the header welds (circumferential or longitudinal).

4.2 Heat Treatment

a. In addition to the requirements of ASME B31.3 post weld heat treatment (PWHT) is required for the following services:

(1) Pressure retaining components for 1 Cr- 1/2 Mo, 1 1/4 Cr-1/2 Mo, and 2 1/4 Cr – 1 Mo (regardless of size, thickness or product form) shall be postweld heat treated (PWHT) in accordance with the requirements of ASME B31.3. No exceptions form heat treatments are permitted.

(2) Monel piping in HF acid service

(3) Killed Carbon steel piping containing amines at a concentration greater than 2.0 weight percent

(4) Any other service as shown on UOP P&ID’s and / or specified in Project Specification 801.

(5) Killed Carbon Steel piping requiring PWHT shall be specified with 1/8 inch (3.0 mm) corrosion allowance minimum.

b. The weld metal tensile strength for killed carbon steel pipe in hydrogen sulfide service shall be essentially the same as the pipe being welded and all welds except socket welds shall have a maximum weld hardness of 200 Brinell. At least one hardness reading shall be taken of every piping weld joint with the reading taken near the center of the weld. Readings shall be taken with a Telebrineller or equal instrument calibrated at 200 Brinell. Where weld hardnesses exceed 200 Brinell, the welds shall be postweld heat treated.

c. When Charpy V-notch impact testing is required for a component that will be heat treated, the test specimens shall be supplied in the same heat treated condition as the new pipe.

d. Large diameter piping shall be supported and stiffened to prevent distortions during heat treatment.

e. Flange facings shall be protected against oxidation during heat treatment.

f. Flame impingement is prohibited at all times.

g. Piping requiring post weld heat treatment shall have all welded-on nonpressure attachments installed by the shop fabricator prior to heat treatment.

5. NONDESTRUCTIVE EXAMINATION

5.1 General

a. Examination shall be in accordance with ASME B31.3.

b. Required radiography may be performed before or after PWHT. If performed before PWHT, an additional radiography or, alternatively ultrasonic examination shall be performed after PWHT.

c. Welds between dissimilar materials shall be examined by the method and to the extent required for the material requiring the more stringent examination.

d. Welds joining non-pressure retaining components to pressure retaining components shall be fully dye penetrant or magnetic particle examined.

e. ASME Class 900 and greater cast valve assemblies and integral flanges in hydrogen service shall have a casting quality factor of 100 percent. The examination shall be performed by radiography in accordance with ASME Section VIII, Division 1, Appendix 7. For 2 inch and smaller valves, if radiography is not possible, a helium mass spectrometer test (probe technique) in accordance with ASME Section V, Subsection A, Article 10, Appendix V is acceptable. Casting repairs and identification shall meet the requirements of paragraph 7-4 and 7-5 of Appendix 7 of ASME Section VIII, Division 1.

5.2 Butt Welds

a. Circumferential pressure retaining butt welds for carbon steel piping for flanges of ASME Class 900 or greater shall be 10% examined by random radiography. Ten percent is defined as full examination of one circumferential weld in ten for each size.

b. Branch welds in carbon steel piping shall be examined by spot radiography. If radiography is not possible, the branch welds shall be spot ultrasonically examined.

c. Circumferential pressure retaining butt welds for all Chrome-Moly and stainless steel piping shall be examined by 100% radiography. Branch welds shall be examined by 100% radiography. If radiography is not possible, the branch welds shall be 100% ultrasonically examined.

d. Circumferential pressure retaining butt welds in carbon steel and low alloy piping which operates at temperature below -20°F (-29°C) shall be examined by 100% radiography.

e. Circumferential pressure retaining butt welds of core piping for jacketed system shall be examined by100% radiography before the jacket is installed.

5.3 Socket Welds

a. Socket welds in carbon steel piping systems shall be examined by 100% radiography, if practical or examined by dye penetrant or magnetic particle.

b. Socket welds in Chrome-Moly, and stainless steel piping shall be examined by 100% radiography. If radiography is not possible, examination shall be performed by 100% ultrasonic.

6. PRESSURE TESTING

6.1 Testing Medium and Conditions

a. Hydrostatic test methods shall be used for pressure testing.

b. Pneumatic testing may be used only when hydrostatic testing is not feasible and is accepted by the Owner.

c. For 1 Cr – 1/2 Mo, 1 1/4 Cr – 1/2 Mo and 2 1/4 Cr – 1 Mo piping the minimum METAL temperature during pressure testing shall be at least 30ºF (17ºC) above the brittle-ductile transition temperature of all pressure retaining components at the time of pressure testing, but not less than 60ºF (15 ºC). The brittle-ductile transition temperature shall be determined by Charpy V-notch impact testing. If the required impact test data is not available, the pressure test temperature shall be 30°F (17°C) above the design minimum metal temperature or the temperature at which impact testing was performed, if lower than the design minimum temperature, but not less than 60 ºF (15 ºC).

d. The hydrostatic test medium shall be clean, fresh, potable water. Water used for hydrostatic testing of austenitic stainless steel pipe shall have a chloride content less than 50 ppm. If the chloride content is greater than 50 ppm and less than 250 ppm, a sufficient quantity of sodium nitrate shall be added to provide a 0.5% by weight sodium nitrate solution. Water with a chloride content greater than 250 ppm shall not be used for austenitic stainless steel piping.

e. The temperature of the water throughout the piping system shall be at least 50ºF (10ºC) at all times during the test. Other test mediums shall be at least 20ºF (11ºC) above their freezing or dew point temperatures.

6.2 Procedure

a. Testing shall commence after the final field erection of piping.

b. Testing shall be performed after the completion of PWHT, if required.

c. Testing shall be completed before primers, paint, or other coatings are applied.

d. Weld seams, flanged and threaded connections and vent holes shall not be insulated until pressure and leak testing is completed.

e. Testing shall be completed before the installation of internal refractory linings. As an alternate, pneumatic testing may be performed with refractory linings present, however the weld seams must not be covered with refractory.

f. Welded reinforcing pads shall be pneumatically leak tested.

g. During testing the piping shall be supported so that local stresses in the pipe do not exceed 90% of the material minimum yield strength.

h. Air pockets shall be vented before commencing pressure test.

i. Vacuum conditions shall be prevented during the draining of test fluid from the piping.

j. Piping shall be thoroughly drained and dried after completion of testing.