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1. **GENERAL**

1.1 **SCOPE**

1.1.1 This specification covers the requirements of materials selected for piping to be used for Company Project.

1.1.2 This specification covers specific requirements for the selection of materials to be used in the construction and fabrication of all process and utility piping systems except the following items:

1) Fabrication ducts, square ducts and other special piping
2) Heating, plumbing, ventilation and similar piping inside buildings
3) Instrumentation tubing

1.1.3 **Instrument Piping**

This specification does not apply to instrument piping with the exception of the first isolation valve which isolates the instrument from the general piping, or the first two isolation valves when dual isolation valves are specified.

1.1.4 This specification shall be applied to piping materials indicated on piping & instrument diagram (P & ID) and utility flow diagram (UFD).

1.1.5 **Limits of the Piping System**

This specification applies to the following items when connected to a nozzle located on a piece of equipment:

1) Flanges, gaskets, bolts, and nuts at the equipment nozzle
2) Any valves or blinds connected to the equipment nozzle
3) Piping between the equipment nozzle and the first isolation valve going to an instrument (or second valve if dual isolation is specified)
2.2 CODE AND STANDARDS

1.2.1 All codes and standards specified in this document refer to the latest revision at the time of signing the contract for this project unless otherwise specified.

1.2.2 This specification is based on the American Society of Mechanical Engineers (ASME) Code for Pressure Piping, ASME B31.3, "Process Piping" or ASME B31.1 "Power Piping" (ASME Section I).

1.2.3 Design, fabrication, testing, and inspection of piping materials shall be accomplished in accordance with the applicable codes and standards, which are in effect as of the date contract signed.

1.2.4 Where conflicts between the specification and other drawings, documents, codes, standards and specifications, etc., the most stringent shall be applied.

1.2.5 The code and standards shall be applied below lists, but not limited to the following;

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME B31.1 Power Piping
- ASME B31.3 Process Piping
- ASME B1.1 Unified Inch Screw Threads
- ASME B1.20.1 Pipe Threads, General Purpose (Inch)
- ASME B16.5 Piping Flanges and Flanged Fittings
- ASME B16.9 Factory-Made Wrought Steel Butt welding Fittings
- ASME B16.10 Face-to-Face and End-to-End dimensions of Valves
- ASME B16.11 Forged Fittings, Socket-Welding and Threaded
- ASME B16.20 Metallic Gaskets for Pipe Flanges-Ring Joint, Spiral Wounds and Jacketed
- ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
- ASME B16.25 Butt welding Ends
- ASME B16.34 Valves-Flanged, Threaded, and Welding End
- ASME B16.47 Large Diameter Steel Flanges, NPS 26 through NPS 60
- ASME B16.48 Line Blanks
- ASME B18.2.1 Square and Hex Bolts and Screws (Inch Series)
- ASME B18.2.2 Square and Hex Nuts (Inch Series)
- ASME B36.10 Welded and Seamless Wrought Steel Pipe
- ASME B36.19 Stainless Steel Pipe
ASME B46.1  Surface Texture (Surface Roughness, Waviness, and Lay)

AMERICAN BOILER AND PRESSURE VESSEL CODE

ASME Section I  Rules for Construction of Power Boilers
ASME Section II  Materials
ASME Section V  Nondestructive Examination
ASME Section VIII  Rules for Construction of Pressure Vessels
ASME Section IX  Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

AMERICAN PETROLEUM INSTITUTE (API)

ANSI/API SPEC.5L  Specification for Line Pipe
API 594  Check Valves : Flanged, Lug, Wafer and Butt-Welding
API 598  Valve Inspection and Test
API 599  Metal Plug Valves - Flanged and Welding Ends
API 600  Steel Gate Valves – Flanged and Butt-Welding Ends, Bolted Bonnets
API 602  Steel Gate, Globe and Check Valves for Size NPS 4(DN100) and Smaller for the Petroleum and Natural Gas Industries
API 603  Corrosion-Resistant, Bolted Bonnet Gate Valves-Flanged and Butt-welding Ends
API 607  Fire Test for Soft-seated Quarter-turn Valves
API 608  Metal Ball Valves-Flanged, Threaded, and Welding End
API 609  Butterfly Valves: Double Flanged, Lug- and Wafer-Type

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM  For materials of regular piping part

BRITISH STANDARD (BS)

BS 1868  Steel Check Valves(Flanged and Butt-Welding Ends) for the Petroleum, Petrochemical and Allied Industries
BS 1873  Steel Globe and Globe Stop and Check Valves(Flanged and Butt-Welding Ends) for the Petroleum, Petrochemical and Allied Industries
BS 6364  Valve for Cryogenic Service
BS EN ISO 17292  Metal Ball Valves for Petroleum, Petrochemical and allied industries
BS EN ISO 12266-1  Industrial Valves – Testing of Valves
BS EN ISO 12266-2  Industrial Valves – Testing of Valves
**PIPING MATERIAL SPECIFICATION**

(PROJECT STANDARDS AND SPECIFICATIONS)

<table>
<thead>
<tr>
<th>MANUFACTURERS STANDARD SOCIETY (MSS)</th>
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<td>MSS-SP-110</td>
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<thead>
<tr>
<th>DEUTSCHE NORM (DIN)</th>
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<tbody>
<tr>
<td>DIN 30670</td>
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</table>

<table>
<thead>
<tr>
<th>OTHERS</th>
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<tbody>
<tr>
<td>ISO</td>
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<tr>
<td>NACE</td>
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<tr>
<td>PFI</td>
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</tbody>
</table>
1.3 PRESSURE-TEMPERATURE DESIGN

1.3.1 The design pressure-temperature to be used as a basis for the design of piping system and selection of standard piping material components shall be in accordance with the requirements of the ASME B31.3 “Process Piping” or ASME B31.1 “Power Piping” (ASME Section I) or other governing codes.

1.3.2 Design pressure-temperature limitations are in general based on the flange ratings ASME B16.5, ASME B16.47 and are shown on individual line class specifications, unless otherwise noted.

1.3.3 These design conditions shall not be less than the most severe conditions of coincident internal and external pressure and temperature expected during service including start-up, shutdowns, and possible emergency situations (e.g. emergency depressurization, etc).

1.3.4 Unless otherwise specified, piping component wall thickness, specified in the pipe classes are based only on design consideration of pressure, temperature, and allowances for corrosion and minus tolerance according to ASME B31.3 “Process Piping” or ASME B31.1 “Power Piping” (ASME Section I).

1.3.5 Piping component wall thickness do not include additional thickness required to compensate for design considerations such as thermal loads due to restraints, live load, hydraulic shock or load and sources from other caused all of which must be considered in the design of piping systems.

1.3.6 Pipe classes intended for vacuum service or steam service and some pipe classes, especially requested for vacuum design condition, must be verified for vacuum design condition.

1.4 PIPE WALL THICKNESS ALLOWANCE

1.4.1 Wall thickness as determined by design formulas shall be increased to provide for:
1) Corrosion allowance
2) Tolerances for threading and machining, thinning allowance when pipe is to be bent
3) Pipe manufacturer's manufacturing tolerances
1.4.2 Corrosion and erosion allowances are not set forth in the code, but are left to the discretion of the designer. The following corrosion allowances are specified as minimum requirement:

<table>
<thead>
<tr>
<th>Material</th>
<th>Corrosion Allowance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon steel and alloy up to 9 Cr-Mo in dry service</td>
<td>1.6 mm</td>
<td></td>
</tr>
<tr>
<td>Carbon steel and alloy up to 9 Cr-Mo in wet service</td>
<td>3.2 mm</td>
<td></td>
</tr>
<tr>
<td>Galvanized steel</td>
<td>1.6 mm</td>
<td></td>
</tr>
<tr>
<td>Stainless steel</td>
<td>0 mm</td>
<td></td>
</tr>
<tr>
<td>Non-Metal such as GRP, HDPE, PVC, Non-metal lined, etc.</td>
<td>0 mm</td>
<td></td>
</tr>
</tbody>
</table>

In special cases a greater corrosion allowance may be required. If a higher corrosion allowance for a specific service is specified in any of the specifications, then that corrosion allowance will govern for that service. Likewise, if the Licensor specifies a greater corrosion allowance than that specified in this paragraph or one of the other specifications, then the Licensor’s corrosion allowance will govern for that service.

1.4.3 Threading and Machining Tolerances

1) Pipe which is to be threaded shall have an allowance equal to the thread depth added to the calculated wall thickness.
2) For machine surfaces or grooves where the tolerance is not specified, the tolerance shall be assumed to be 0.5 mm in addition to the specified depth cut.

1.4.4 Manufacturing Tolerances

The manufacturers minus tolerance for wall thickness must be added to the calculated wall thickness in accordance with applicable ASTM or API.
1.4.5 Dual Grade Materials

Where dual grade materials i.e 316/316L or 304/304L Stainless steel is available, they shall be used. The corresponding allowable stresses of the higher strength material shall be used in calculating wall thicknesses and the pressure limits of the class.

1.5 ENDS

Unless otherwise specified, the ends shall be to the following standard:

<table>
<thead>
<tr>
<th>Ends Type</th>
<th>Standard</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW / SCRD</td>
<td>ASME B16.11</td>
<td></td>
</tr>
<tr>
<td>BW</td>
<td>ASME B16.25</td>
<td></td>
</tr>
<tr>
<td>Flanged</td>
<td>ASME B 16.5 and ASME B16.47 Series 'B7 Taylor Forge/AWWA</td>
<td></td>
</tr>
<tr>
<td>Threaded</td>
<td>ASME B1.20.1 (NPT, Taper Threads)</td>
<td></td>
</tr>
</tbody>
</table>

1.6 UNITS

All units are expressed in the international SI system, except for nominal bore sizes of pipes, which are in inches. Pressures are gauge pressures (in bars), unless otherwise stated. Temperatures are in degrees Celsius. Pressure/Temperature ratings of flanges are based on the latest version of the ASME B 16.5 and ASME B16.47.

1.7 LANGUAGE

The language used in drawings, correspondence and other technical document shall be English.
2. MATERIAL

2.1 GENERAL

2.1.1 Piping materials shall be in accordance with ASME B31.3 or where applicable.

2.1.2 Metallic piping shall be used temperature limitation as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Maximum Design Temperature</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
<td>427°C</td>
<td></td>
</tr>
<tr>
<td>P11 (1¼ Cr-½ Mo) Steel</td>
<td>550°C</td>
<td></td>
</tr>
<tr>
<td>P12 (1Cr-½ Mo) Steel</td>
<td>550°C</td>
<td></td>
</tr>
<tr>
<td>P22 (2¼ Cr-1Mo) Steel</td>
<td>550°C</td>
<td></td>
</tr>
<tr>
<td>P91 (9Cr-1Mo-V) Steel</td>
<td>600°C</td>
<td></td>
</tr>
<tr>
<td>Type 304/304L/316/316L/321/347</td>
<td>538°C</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type H Stainless Steel (304H, 316H, etc.)</td>
<td>800°C</td>
<td></td>
</tr>
<tr>
<td>800H (Incoloy)</td>
<td>950°C</td>
<td></td>
</tr>
</tbody>
</table>

2.1.3 The following pipe sizes shall not be allowed: ½", 1¼", 2½", 3½", 5, 7, and 9 inches. However, in cases where the use of these sizes cannot be avoided, the required piping material, fittings, flanges, valves and gaskets shall be the same material as next larger sizes in the applicable piping class.

2.1.4 Material used in the fabrication of piping and piping components shall be new, clean and free from rust, pits and obvious defects.

2.1.5 For 50" and larger pipes and fittings, two longitudinal welding seam (double seam) 180 degree apart shall be acceptable.
2.1.6 The use of 3.5% nickel material for either piping components or equipment is prohibited. 304 SS shall be used in place of or 3.5% nickel.

2.1.7 All underground piping components shall be coated or cold tape wrapping except non-metal such as HDPE, FRP, etc.

2.1.8 Several common materials are now produced as “dual certified” or are multiple marked, meaning that these materials conform to more than one material specification or grade. Any material so marked may be used interchangeably for any or all of the corresponding materials called out in the standard. The most common example is “quad-stenciled” seamless steel pipe, which is marked “A(SA)53-B/A(SA)106-B/API-5L-B/API-5L-X42”. This pipe may be used anywhere that A(SA)53 Gr.B Type S or A(SA)106 Gr.B or API 5L-B or API 5L-X42 is specified. Another is “dual-stenciled”304/304L stainless which may be used wherever either 304 or 304L is specified, or “dual-stenciled”316/316L stainless which may be used wherever either 316 or 316L is specified. Material that are not multiple or dual-marked may not be used in this manner.

2.1.9 Material used in the piping systems shall comply with ASTM standards. During the engineering and procurement stage the Company will consider allowing other internationally recognized standards to be used for limited application in the piping system.

2.1.10 Galvanized pipes and fittings and flanges, etc. shall be only hot dip galvanized to ASTM A153. Threads for galvanized items shall be clean and free from any galvanizing. External surfaces where galvanizing has been burned-off during field welding, etc., shall be wire brushed and zinc coated or cold galvanized using proper paint only for external surfaces.

2.1.11 Low Temperature Carbon Steel (LTCS) is defined for this project as Charpy V-notch impact-tested carbon steel. The minimum low design temperature where LTCS may be used is -46 °C.

2.1.12 Carbon steel piping and components requiring welding or heat cutting (torch) shall have carbon content less than 0.33% wt%.

2.1.13 Austenitic stainless steel material (pipe, fitting, flange, plate, forging, casting, etc.) shall be furnished in the solution annealed condition.
2.1.14 Structural grade steel is prohibited from being used in any piping system except for structural support.

2.1.15 Undressed flame cut weld bevels on butt-welding ends are not permitted.

2.1.16 Material marking methods shall be in accordance with applicable product specifications, except that hard stamping using other than "low stress" (round nose) dies is prohibited.

2.1.17 Low alloy 2¼ Cr-½ Mo steels (A335-P22, A691-2¼ Cr, A234-WP22, A182-F22, A387 Gr.22, etc.) are used in piping material, the carbon content of the base material, weld metal and weld filler metal shall have greater than 0.05%.

2.1.18 When piping components shall be required 100% Radiography Test to weld area, the piping components shall be provided a weld joint efficiency of 1.00.

2.1.19 All forgings shall be supplied in normalized condition except designated other heat treatment in related code and standard, and weld repair are not acceptable.

2.1.20 Positive Material Identification (PMI) test shall be applied in accordance with specification for Positive Material Identification.

2.1.21 Piping material shall be color marked in accordance with specification for Color Marking for Piping Material Identification.