Engineering Standard

09 March 2022

SAES-L-110
Limitations on Pipe Joints and Components

Document Responsibility: Piping Standards Committee

Contents

Summary of Changes

Paragraph Number		Change Type	Technical Change(s)
Previous Revision (28 February 2021)	**Current Revision** (09 March 2022)		
1.2	1.2	Addition	Added ASME B31.12
3.1	3.1	Addition	Added reference SAES-W-016 Welding of Special Corrosion-resistant Materials
3.2	3.2	Addition	Added reference ASME B31.12 Hydrogen Piping and Pipelines
5.1	5.1	Addition	Added SAES-W-016
11.5	11.5	Editorial	Commercial names “olets” have been replaced by generic description.
14.2 Notes	14.2 Notes	Editorial	Change LPD to LPTSD
Chart 1	Chart 1	Modified	Added Integrally Self-Reinforced Nipple Branch Outlet as an option for Region 5.
Chart 1 Notes	11.5 and Chart 1 Notes	Editorial	Commercial names “olets” have been replaced by generic description.

1. Scope

1.1 This standard covers the limitations on various types of piping joints and components used in metallic piping for pressure piping systems within the context of SAES-L-100.

1.2 This standard covers additional requirements to ASME B31.1, ASME B31.3, ASME B31.4, ASME B31.8, and ASME B31.12 piping codes and defines requirements governing the selection of metallic pipe fittings, bends, laterals, and branch connections for plant piping and pipelines. Tube fittings and other specialty fittings are outside the scope of this standard.

2. Conflicts and Deviations

Any conflicts between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed to the EK&RD Coordinator.

Any deviation from the requirements herein shall follow internal company procedure SAEP-302.

3. References

All referenced specifications, standards, codes, drawings, and similar material are considered part of this engineering standard to the extent specified, applying the latest version, unless otherwise stated.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-85	Suppliers Evaluation and Approval
SAEP-302	Waiver of a Mandatory Saudi Aramco Engineering Requirement

Saudi Aramco Engineering Standards

SAES-A-004	General Requirements for Pressure Testing
SAES-A-021	Sulfur Recovery Units Design Requirements
SAES-B-006	Fireproofing for Plants
SAES-L-100	Applicable Codes and Standards for Pressure Piping Systems
SAES-L-109	Selection of Flanges, Stud Bolts, and Gaskets
SAES-L-136	Pipe, Flange, and Fittings Material Requirements
SAES-L-310	Design of Plant Piping
SAES-W-011	Welding Requirements for On-plot Piping

SAES-W-012	Welding Requirements for Pipelines
SAES-W-016	Welding of Special Corrosion-resistant Materials

Saudi Aramco Materials System Specifications

01-SAMSS-010	Fabricated Steel Piping
02-SAMSS-005	Butt Welding Pipe Fittings
02-SAMSS-013	Stainless Steel and Nickel Alloy Butt Welding Pipe Fittings

Saudi Aramco Standard Drawings

AB-036090-001	Joints for Welding Cement Lined Pipe
AE-036175-001	Detail of Welding Boss, Threaded Connection to Vessels and Lines
AC-036404-002	Flame Impingement Shield for Flangeless Valve
AB-036521-001	Bridge Weld and Typical Brace Seal Welded and Socket Welded Valves On Process Lines
AD-036643-001	Detail Heavy Welding Boss, Socket Weld Connections
AB-036719-001	Reinforcement of Welded Branch Connections
AE-036768-001	External Welding Sleeves for Cement Pipe

3.2 Industry Codes and Standards

American Society of Mechanical Engineers

ASME B16.11	Forged Fittings, Socket-Welding and Treaded
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.25	Buttwelding Ends
ASME B16.3	Malleable Iron Threaded Fittings Classes 150 and 300
ASME B16.9	Factory-made Wrought Buttwelding Fittings
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.4	Pipeline Transportation Systems for Liquids and Slurries
ASME B31.8	Gas Transmission and Distribution Piping Systems

American Society for Testing and Materials

ASME B31.12	Hydrogen Piping and Pipelines American Society for Testing and Materials

ASTM A105	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A182	Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A234	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A350	Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

Manufacturers Standardization Society

MSS SP-75	High-Strength, Wrought, Butt-Welding Fittings
MSS SP-83	Class 3000 and 6000 Pipe Unions, Socket Welding and Threaded (Carbon Steel, Alloy Steel, Stainless Steels, and Nickel Alloys)
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings-Socket Welding, Threaded, and Buttwelding Ends.

American Petroleum Institute

API STD 602	Compact Steel Gate Valves

4. Terminology

4.1 Definitions

Hazardous Service: Fluid services that are flammable, or toxic, or damaging to human tissue according to the definitions of ASME B31.3 (para 300.2).

Metal to Metal Seal Joint: A friction generated joint that relies on the mechanical fit between metals to seal against pressure where the ends are hydraulically pressed together by high compressive forces.

Nominal Pipe Size: Indicated as NPS which is followed by the specific size designation number without an inch symbol.

Diameter Nominal: Indicated as DN which is followed by the specific size designation number without a mm symbol.

Proprietary/Specialty Coupling: A joint that is developed and possibly patented by a particular firm and could be not covered by any Industry Code.

5. Welded Joints

5.1 Pipe Welds

Welds in metallic piping shall conform to the requirements of the welding standards SAES-W-011, SAES-W-012 , SAES-W-016 and other Standards referenced therein.

5.1.1 When wall thickness ratio of joined pipes is less than or equal to 1.5, joint design details shall comply with the respective ASME B31 design code and shall have limitation to comply with ASME B16.25.

5.1.2 When wall thickness ratio of joined pipes is greater than 1.5, end preparations and geometry shall comply with ASME B16.25 “Butt Welding Ends”.

5.1.3 When the wall thickness of the fitting or pipe at the welding end exceeds the wall thickness of the matching pipe resulting in an unequal external and/or internal diameters, the welded joint design shall comply with Figure 434.8.6-2 of ASME B31.4 or Figure I-5 in ASME B31.8 for graphic details of joint designs (regardless of the design code).

5.2 Socket Welds

5.2.1 The maximum size of socket-welded joints in hazardous services shall be DN 40 (NPS 1-1/2) for new construction. Maximum DN 50 (NPS 2) may be used in hazardous service for maintenance, minor field modifications of existing piping systems, and when necessary to match existing equipment connections.

5.2.2 For sour service, socket-welded joints should be avoided. In case they could not be avoided, the maximum size of socket-welded joints shall be DN 25 (NPS 1).

Note:

Generally, socket welded joints should be avoided in any service where crevice corrosion, severe erosion, or cyclic loading may occur.

5.2.3 Socket weld joints are not permitted in location where high vibration can occur (such as high velocity gas control valves and reciprocating machinery).

5.2.4 The axial gap between male and female component, as shown in Figure 328.5.2C of ASME B31.3 code, shall be maximum of 3 mm and minimum of 1.5 mm. This gap is required prior to welding and as per SAES-W-011.

Note:

This axial gap requirement is only applicable prior to new installation of socket welds, the objective of the gap is to ensure that there is enough pipe inserted into the socket, and to make sure it is not bottomed out, which could create the potential for cracking in the weld. The gap does not apply to piping already installed with welding successfully completed.

5.3 Fillet Welds

The use of sleeve couplings per Standard Drawings AE-036768-001 and AB-036090-001 shall be limited to cement lined pipe in water services such as firefighting piping systems and oily water service.

6. Prohibited Piping Joints and Components

The following piping components are not allowed and shall not be used in pressure piping system within the scope SAES-L-100:

a) Caulked joints.

b) Soldered, brazed, and braze-welded joints.

c) Expanded joints: They are slip on type of joints using O-ring to seal the pressure.

d) Bell-type and packed joints unless otherwise specified in this standard document.

7. Threaded Joints

7.1 The thread joints shall be taper pipe thread (NPT) conforming to ASME B1.20.1 unless otherwise required by specifications for specific connections.

7.2 In hazardous services, the maximum size of threaded connections shall be DN 40 (NPS 1.5) for standard fittings and valves, and DN 50 (NPS 2) maximum when required for maintenance, or minor field modifications of existing piping systems, or to match threaded specialty devices such as scraper signals and access fittings for corrosion monitoring.

Threaded connection shall not be used in hydrogen service

7.3 In non-hazardous services, the maximum size of threaded connections shall be DN 80 (NPS 3) for standard fittings and valves, and DN 100 (NPS 4) maximum on special items.

7.4 The minimum length of the engaged threads pipe shall meet the requirements of ASME B1.20.1 for taper pipe thread. The minimum number of engaged pipe threads shall meet the requirements of Table 1.

Table 1 - Thread Engagement Requirements for Taper Pipe Threads

DN(NPS)	Number of Threads Engaged
DN 15, 20 (NPS 1/2, 3/4)	6
DN 25, 40 (NPS 1, NPS 1-½)	7
DN 50, 80 (NPS 2, NPS 3)	8
DN 100 (NPS 4)	10

7.5 The thread sealing material shall be suitable for the service and temperature. PTFE tape shall not be used for service temperature greater than 204°C on threaded connections.

7.6 Threaded joints are not permitted in location where high vibration can occur.

8. Flanged Joints

8.1 Flanged connections shall be avoided when butt-welded joints can be used in services and locations where leaks are likely to occur (e.g., cyclic or vibration services), or will cause serious hazard (e.g., potentially toxic material), or are difficult to control, such as the following:

a) Steam in ASME Class 900 pressure rating

b) In the fully restrained portion of cross-country pipelines and in underwater pipelines

c) In locations where the piping will be subjected to large bending or other external loads

d) On buried piping system.

Note:

Flanges are typically used when required for equipment maintenance or operation in aboveground piping, or in services with FBE where flanged spools are required.

8.2 Flanged connections with long exposed bolts for sandwiched components shall not be used in fire hazardous zone unless the bolting is protected by a fire resistant shield such as illustrated on Standard Drawing AC-036404-002 or equivalent method. (Ref. SAES-B-006).

8.3 Selection of flanges shall be in accordance with SAES-L-109.

9. Seal Welding of Threaded Joints

9.1 Seal welds are permitted to be used to prevent leakage of threaded joints. It shall not be considered as contributing factor to the strength of the threaded joints. Threaded joints can be seal welded prior to hydrotest, provided that the full threaded engagement of Table 1 requirements are met.

9.2 Seal welding of all threaded joints up to the first block valve is required in the following services and applications:

a) All hydrocarbons.

b) Boiler feed water, condensate, and steam systems utilizing ASME Class 300 and higher flange ratings.

c) Toxic materials such as chlorine, phenol, hydrogen sulphide, etc.

d) Corrosive materials such as acid, caustic, etc.

e) Oilfield chemicals (e.g. corrosion inhibitors, emulsifiers, electrolytes, etc.)

f) Piping which is subject to vibration, whether continuous or intermittent as per SAES-L-310 requirements.

9.3 Seal welding is not required for the following services and applications:

a) Thermowells

b) Bar stock plugs downstream of a seal-welded block valve.

c) Special devices such as access fittings and scraper signals.

d) Joints which require frequent disassembly and are located downstream of a seal welded block valve, e.g., sample connections.

e) Instrument piping downstream of the primary instrument isolation valve.

f) Pipe union ring threads and joints with elastomer O-rings.

g) Threaded joints, downstream of a seal welded root valve, which discharge directly to an open drainage system or to the atmosphere.

h) Extended body valves with integrally reinforced welding end per API STD 602.

9.4 Where seal welding is required, the seal weld shall be a fillet weld going from the outer diameter of the female part, and it should be smooth with slight concavity as allowed by ASME B31 codes as stated in paragraph 1.2, to the male part covering all exposed threads without undercut.

9.5 PTFE tape or joint compounds shall not be used in threaded connections requiring seal welding.

10. Pipe Fittings General Requirements

10.1 All metallic pipe fittings shall be fully compatible with the adjoining pipe and shall be subject to the limitations of SAES-L-136 or carbon steel line pipe.

10.2 The pipe fittings shall be sourced from an approved manufacturer.

10.3 Carbon steel fittings shall be in accordance with the requirements of 02-SAMSS-005.

11. Threaded and Socket Welding Fittings

11.1 For steel piping in hazardous services, threaded and socket welding fittings shall conform to ASME B16.11 Class 3000, Class 6000 or higher.

11.2 Pipe unions in hazardous services shall be limited to Class 3000 threaded or socket welding forged steel unions in accordance with MSS SP-83. The material shall be carbon steel per ASTM A105, ASTM A350 or alloy steel per ASTM A182.

Pipe unions shall not be installed in the pipe section between the main pipe run and root valve.

11.3 Threaded bushings with one size reduction shall not be used. When bushings are allowed, only hex head steel bushings shall be used. Flush steel bushings are not permitted.

11.4 Welding bosses shall be forged steel ASTM A105, ASTM A350 or ASTM A182, as applicable, as shown on Standard Drawings AE-036175-001 or AD-036643-001.

11.5 Integrally reinforced welding outlets that confirm to MSS SP-97 or equivalent approved design in Class 3000, 6000, or higher, as applicable, which abut the pipe wall with a full penetration weld are acceptable.

11.6 Malleable iron screwed fittings shall conform to ASME B16.3 Class 150 and shall be galvanized and limited to non-hazardous services (Category “D”), except that pipe unions shall be Class 300.

11.7 Pipe plugs for use in metallic piping shall be solid body, bar-stock, or forged steel plugs in accordance with ASME B16.11.

12. Steel Butt Welding Fittings

12.1 The material and purchasing requirements of carbon steel buttweld fittings to: ASTM A234 Grade WPB and MSS SP-75 shall conform to the requirements of 02-SAMSS-005.

12.2 Steel butt welding fittings shall conform to 02-SAMSS-005.

12.3 Stainless-steel butt-welding fittings shall conform 02-SAMSS-013.

12.4 Integrally reinforced welding outlets shall be as per MS SP-97.

12.5 Miter elbows are not permitted.

12.6 Unlisted Fittings/Components shall be as per requisites listed in ASME B31.3 paragrah 304.7.2, regardless of the applicable B31 Code.

13. Branch Connection Type and Fittings

13.1 Selection of the tee branch connections type and fittings shall be as follows:

13.1.1 For new construction of metallic piping selection shall be made in accordance with the Chart 1.

13.1.2 In case a branch connection with reinforcement has been selected according to paragraph 13.1.1, the size of the reinforcement pad shall be per the applicable Code and in accordance to SASD AB-036719-001. In case no reinforcement pad is required according to code calculations, it shall have a reinforcement pad size equal to 50% of branch diameter as a minimum.

13.1.3 For field modifications to existing piping, the branch connections as shown on AB-036719-001 with proper reinforcement are acceptable..

13.1.4 Long Welding Neck Flange directly connected to header are not acceptable, the connection to header shall be in accordance to Chart 1.

13.2 Laterals and Crosses

13.2.1 Crosses are not permitted except where mandatory for the process such as in sulfur recovery unit rundown/drain lines as per requirements in SAES-A-021. Crosses shall be procured as fitting as per ASME B16.9 and 02-SAMSS-005. Fabrication of crosses from pipes is not permitted.

13.2.2 Laterals shall be used only when required by Saudi Aramco standards. They should be used for low pressure system, less than 1.034 MPa (150 psig) such as flare lines or when required by Process/Licensor (regardless the pressure).

13.2.3 All laterals shall be designed for a bursting strength at least equal to the bursting strength of the adjoining pipe.

13.2.4 Laterals fittings shall be as per 02-SAMSS-005.

13.2.5 Laterals manufactured by welding the branch pipe directly to the run pipe shall be designed according to the code and shall have complete encirclement reinforcement, and shall be as per 01-SAMSS-010 and subjected to minimum 90% SMYS hydrotest pressure.

13.2.6 100% NDT in lieu of hydrotest may be accepted by complying to SAES-A-004 Appendix H. In case, welds cannot be ultrasonically inspected in accordance with notes 5 and 6 of Appendix H SAES-A-004, as an alternative to Ultrasonic Test, in-process examination may be carried out as specified in paragraph 344.7, ASME B31.3 and the examination methods shall include dye penetrant (PT)/Magnetic particle (MT) in addition to visual inspection.

13.3 Branch connections, such as those for drain and vent connections, on tees, elbows and reducers are not permitted.

14. Specialty and Proprietary Couplings

14.1 Any new proprietary or specialty mechanical joints regardless of service shall be approved by RVL procedures in accordance to SAEP-85.

14.2 Metal to Metal Seal Coupling

Saudi Aramco approved proprietary pipe couplings are limited to onshore pipelines for water services and where internal coating of the girth welds is deemed impractical in the field.

Note:

For any deviation from the above requirements, the waiver submittal shall include Risk Assessment as a part of the technical justification. The Risk Assessment shall be conducted with the guidance and approval of the LPTSD Risk Assessment Group.

14.3 For clamp-type flanges (connectors) refer to SAES-L-109.

15. Small Bore Branch-to-Header Connection for Vibration Service

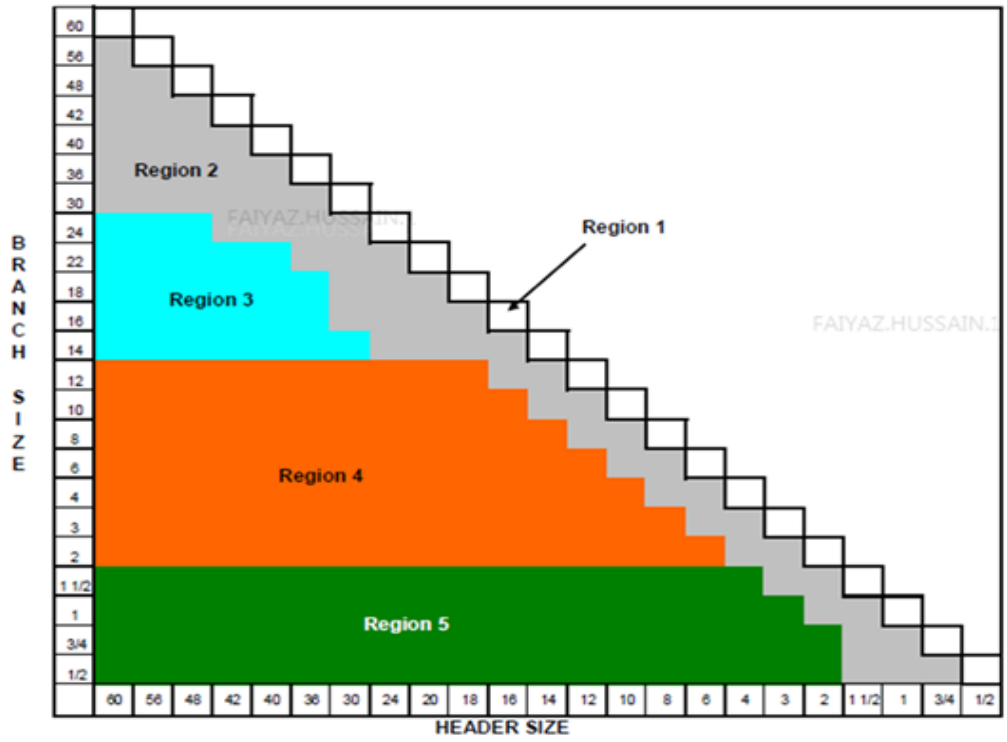
15.1 Particular attention should be made to the design of small bore (NPS 2 and below) connections in piping systems prone to vibration. Additional guidance can be found in Energy Institute document "Guidelines for the avoidance of Vibration Induced Fatigue in Process Piping."

15.2 Gussets shall be provided for small bore piping connections in vibrating service as detailed on AB-036521-001 Figure.4. Gussets are applicable for butt weld and socket weld connections alike.

Document History

09 March 2022	This revision is out of the normal revision cycle, and it is intended to include the Integrally Reinforced Nipple Branch Outlet Fittings as part of the Decarbonization Strategy, include ASME B31.12 reference as part of the Hydrogen Strategy, include SAES-W-016 as reference and delete all terminology that may potentially lead to single sourcing.
28 February 2021	Major Revision was made to align requirements for Crosses to SAES-A-021, add requirements for small bore branches in Vibration services to be aligned with SAES-L-310, upgrade the notes of Chart 1 to be aligned with the Energy Institute Guidelines for Fatigue Induced Cracking Avoidance, and SI units.
10 July 2019	Editorial revision to extend Next Planned Update to 30 April 2021 and removed RVL and brand name.
29 January 2018	Editorial revision.
09 January 2017	Major revision was made to align this document requirements with the international standard ASME B31.3 where hydrotest for fabricated laterals are not mandated.
6 August 2013	Re-issued as “Major Revision” to reaffirm the contents of the document, and changed the "Next Planned Update."

Chart 1 - Branch Connections



LEGENDS

Region-1: Equal Tee

Region-2: Reducing Tee

Region-3: Reducing Tee or Branch weld with reinforcing pad or full encirclement sleeve

Region-4: Integrally Reinforced Forged Branch Outlet Fitting MSS SP-97 (buttwelding ends) or branch weld with reinforcing pad. (See note 5)

Region-5: Integrally Reinforced Forged Branch Outlet Fitting MSS SP-97 (buttwelding ends, socketwelding end, threaded end) or Welding boss per SASD AE-036175 and AE-036643. Usage of Integrally Reinforced Nipple Branch Outlet Fitting is acceptable in-lieu of the normal combination of an Integrally Reinforced Forged Branch Outlet Fitting MSS SP-97 (buttwelding ends, socketwelding end, threaded end) joined to a Nipple. (See note 5)

NOTES:

1. The table is indicated on Nominal Pipe Size (NPS) only for clarity.
2. The Chart-1 applies to 90^{o}, and 30-45^{o} branches.
3. Integrally reinforced fittings per MSS SP-97 may be used when reducing tees are not available and/or if branch connections are of smaller bore size, less than NPS 3.
4. Integrally Reinforced Forged Branch Outlet Fitting MSS SP-97 (socketwelding end, threaded end) may be used for Piping Material Class for small bore branches, less than NPS 3, except where D/t ratio is greater than 100, in which case Reducing Tee shall be used (Region 2).
5. For Services in Vibration (Acoustic Induced Vibration) Piping Material Classes will use only reducing outlet wrought butt-weld tees (or combination of tee and reducer), or Integrally Reinforced Smooth Countered to Lower Stress Intensification Factor. Except this type, all other Integrally reinforced fittings are not acceptable in Acoustic Induced Vibration services.
6. Header/Branch Sizes not covered on this Chart (Greater than NPS 60) shall be calculated and submitted by Design Agency.
7. Integrally Reinforced Forged Branch Outlet Fitting MSS SP-97 (socketwelding) are limited by sour service as per point 5.2.2.