



Engineering Standard

SAES-L-100

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Applicable Codes and Standards for Pressure Piping Systems

Piping Standards Committee Members

Nasri, Nadhir Ibrahim, Chairman

Dib, Tony Georges, Vice Chairman

Balhareth, Nasser Mohammad

Bannai, Nabeel Saad

Fadley, Gary Lowell

Holland, Brad John

Khashab, Jaafar M.

Lewis, Trevor

Mahmoud, Khalid Ahmed

Phan, Howard Cong

Rao, Sanyasi

Rasheed, Mahmood A.

Sharif, Talal Mahmoud

Shiha, Saad Mohammed

Swar, Ahmad H. (ABQ PLANTS)

Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This standard defines the applicable ASME B31.1, B31.3, B31.4 and B31.8 (hereafter called the Codes) for design, construction and inspection of piping systems owned or operated by Saudi Aramco.
- 1.2 This standard sets the rules and basis for selecting the applicable Saudi Aramco Engineering Standards and/or Saudi Aramco Material Systems Specifications that supplement the applicable Codes.
- 1.3 This standard supplements the Codes and defines additional design requirements for piping systems.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department (CSD) of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.3 Mandatory Requirements: All piping standards contain minimum mandatory requirements, normally indicated by the words "shall" or "shall not". However, they do not prohibit alternatives that are equal or better. In questionable cases, the Chairman of Piping Standards Committee in CSD shall be consulted to evaluate the alternatives.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the **latest edition** of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302

*Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

SAES-B-064	<i>Onshore and Nearshore Pipeline Safety</i>
SAES-L-101	<i>Regulated Vendor List for Pipes, Fittings and Gaskets</i>
SAES-L-102	<i>Regulated Vendor List for Valves</i>
SAES-L-105	<i>Material Specifications for Piping Systems</i>
SAES-L-108	<i>Selection of Valves</i>
SAES-L-109	<i>Selection of Pipe Flanges, Stud Bolts and Gaskets</i>
SAES-L-110	<i>Limitations on Piping Joints and Components</i>
SAES-L-120	<i>Piping Flexibility Analysis</i>
SAES-L-125	<i>Safety Instruction Sheet for Piping and Pipelines</i>
SAES-L-130	<i>Material for Low Temperature Service</i>
SAES-L-131	<i>Fracture Control of Line Pipe</i>
SAES-L-132	<i>Material Selection for Piping Systems</i>
SAES-L-133	<i>Corrosion Protection Requirements for Pipelines/Piping</i>
SAES-L-136	<i>Pipe Selection and Restriction</i>
SAES-L-140	<i>Thermal Expansion Relief in Piping</i>
SAES-L-150	<i>Pressure Testing of Piping Systems</i>
SAES-L-310	<i>Design of Plant Piping</i>
SAES-L-350	<i>Construction of Plant Piping Systems</i>
SAES-L-410	<i>Design of Pipelines</i>
SAES-L-420	<i>Scraper Trap Station Piping and Appurtenances</i>
SAES-L-440	<i>Anchors for Buried Pipelines</i>
SAES-L-450	<i>Construction of On-Land and Near Shore Pipelines</i>
SAES-L-460	<i>Pipeline Crossings under Roads and Railroads</i>
SAES-L-610	<i>Non-Metallic Pressure Piping Systems</i>
SAES-L-810	<i>Design of Piping on Offshore Structure</i>
SAES-L-850	<i>Design of Submarine Pipelines and Risers</i>
SAES-O-100	<i>General Requirements Safety and Security</i>

3.2 Industry Codes and Standards

American Society of Mechanical Engineers

ASME B31.1 Power Piping

ASME B31.3 Process Piping

*ASME B31.4 Pipeline Transportation Systems for Liquid
Hydrocarbons and Other Liquids*

*ASME B31.8 Gas Transmission and Distribution Piping
Systems*

3.3 Other References

Safety and Security Directives

SSD/1 Standard Security Fence

4 Definitions

4.1 Conflicts between various definitions shall be resolved by the Piping Standards Committee Chairman.

4.2 List of Definitions

Code Break: The physical location on the piping system where the design Code changes from one Code to another, such as from ASME B31.4 to ASME B31.3.

Critical Plant Equipment and Piping: A designation imposed on equipment or piping system that will entail extra design requirements with the objective to minimize business interruption.

Cross-Country Pipeline: The pipeline and its appurtenances used to transport fluids across the country or offshore between isolated plant areas or camps.

Design Agency: The agency responsible for designing the piping system. It could be the design Contractor, the Lump Sum Turn Key Contractor or in house design organization of Saudi Aramco.

Design Conditions: All conditions (such as pressure, temperature, ambient conditions, service, etc.) that govern all or part of the design and selection of piping components.

Design Factor: It is numerical multiplier used to calculate the allowable stresses for transportation piping systems. This factor is used by ASME B31.4 and ASME B31.8 Codes.

Flowlines: Pipelines connected to oil, gas or water wells for production, injection or well testing.

Hazardous Service: Any fluid service other than Category D as defined in ASME B31.3.

Maximum Allowable Operating Pressure (MAOP): This term refers to the maximum pressure at which a piping system can be operated within the provisions of the applicable ASME B31.4 and or B31.8 codes. It is the maximum internal pressure permitted in the piping system for continued operation at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service.

Normal Operating Conditions: The expected conditions (such as pressure, flow, temperature, ambient conditions, service, etc.) to occur during normal operation per design.

Off-Plot: Off-plot refers to any area outside of the **plot limits**. Off-plot can include plant areas such as roads, pipeways and open lots between plant units.

On-Plot: On-plot refers to any area inside the **plot limit**. On-plot piping is generally, but not necessarily, designed to ASME B31.3 code except in area(s) set aside for piping within other code or government regulations.

Perimeter-Fence: The fence which completely surrounds an area designated by Saudi Aramco for a distinct function (plant or camp).

Plant-Area: The designated area engaged in the production, processing, storage and transportation of crude oil, gas, refined products and their derivatives. It could be inside an onshore perimeter fence, or on the decks of offshore structures.

Plant Piping: Pressure piping system, within an identified **plant-area**.

Plant Utility Service: The supply of steam, water, air, nitrogen or inert gas within a processing plant.

Plot Limit: The plot limit is a boundary, within the plant area, which surrounds a single plant or function. The plot limit may be physical such as a fence (not necessarily an SSD fence), a wall, the edge of a road or **pipe-way**, chains and posts or a boundary indicated on an approved plot plan.

Production Pipelines: Those pipelines engaged in transporting crude oil or gas from the producing wells to the designated facility for processing. These include flowlines, testlines, trunklines and transmission lines.

Process Piping: Pressure piping which is designed in accordance with ASME B31.3. This piping is typically found in petroleum refineries, chemical plants, cryogenic plants, and related processing plants and terminals.

Power Piping: Pressure piping which is designed in accordance with ASME B31.1 and typically found in electric power generating plants.

Testlines: Flowlines that are used for testing an individual producing well without affecting the operation of the trunklines.

Transportation Piping: Pressure piping system that is designed in accordance to ASME B31.4 or/and 31.8. Typically, these pipelines transport hydrocarbon fluids or others between processing plants or storage facilities to export terminals and end users.

Trunklines: Pipelines to which two or more flowlines are connected.

Well Head Piping: The piping system connecting the wellhead to the flowline first isolation valve.

5 Governing Codes and Standards

- 5.1 Except for those excluded by this standard or by the ASME B31 Codes, all Saudi Aramco pressure piping system shall be designed, constructed and inspected to a pre-selected ASME B31 Code as a minimum. The selection of the Code is outlined in section 6.
- 5.2 Except for those excluded by paragraph 5.6 of this standard, all Saudi Aramco pressure piping system shall be designed, constructed and inspected to the applicable Saudi Aramco piping standards, per section 7 of this standard, in addition to the designated ASME B31 Code.
- 5.3 All piping standards shall adopt the latest edition of the applicable ASME B31.1, ASME B31.3, ASME B31.4 and ASME B31.8 Codes for pressure piping.
- 5.4 In cases where applicable Code or Standards are not identified by this standard or clear selection could not be achieved, a resolution by the Piping Standards Committee Chairman shall be made during the early stages of the project development.
- 5.5 The Standards revisions are not retroactively mandatory for piping systems built before their dates of approval.

5.6 Exclusions

The following services are excluded from the scope of ASME B31 piping codes:

- a) Sanitary and other gravity sewers (including oily water) in which the internal pressure from static head and/or friction does not exceed 103 kPa (15 psi). Refer to Saudi Aramco Plumbing and Utilities Standards.
- b) Plumbing (including fuel gas) as defined in the Saudi Aramco Plumbing Code including the plumbing of buildings (control rooms) inside plants.
- c) Stacks, flues, vents and ducts including those for air conditioning and ventilation.
- d) Tubes and tube fittings for boilers, heat exchangers and furnaces.
- e) Piping inside fluid handling or processing equipment (e.g., jetting piping inside a Dehydrator).
- f) Casing, tubing and wellhead valve assemblies in gas, oil or water wells.

6 Applicable ASME Codes

6.1 The following piping systems are designated as Power Piping and shall comply with ASME B31.1 as a minimum:

6.1.1 Steam power generation plants.

6.1.2 Co-generation plants.

6.1.3 Steam generating plants.

6.2 Piping systems within the following facilities shall be designated as Process Piping and shall comply with ASME B31.3 as a minimum:

6.2.1 Refineries and petrochemical plants.

6.2.2 Gas oil separation plants (GOSP).

6.2.3 Gas plants and NGL plants.

6.2.4 Piping systems on offshore platforms except for piping beyond the code break point, which will be considered as transportation piping.

6.2.5 Pump stations within the plot limit of a facility designated as process piping.

6.2.6 Designated pipeways or corridors, within a Process Piping facility.

- 6.2.7 Steam generating facilities within a Process Piping facility.
 - 6.3 The following piping systems, in liquid service, are designated as transportation piping and shall comply with ASME B31.4 as a minimum:
 - 6.3.1 Cross country pipelines in hydrocarbon service having a Reid Vapor Pressure (RVP) less than or equal to 1035 Kpa (150 psig).
 - 6.3.2 Water injection system including pump station, headers, laterals and pipelines.
 - 6.3.3 Transportation pipelines in NGL service. Though its RVP is higher than 150 psig.
 - 6.3.4 Water transportation pipelines.
 - 6.3.5 Pump stations, including NGL service, within a dedicated facility and a plot limit and not within a facility designated as process piping.
 - 6.3.6 Terminals for transporting and shipping crude oil and its derivatives.
 - 6.3.7 Bulk plants including hydrocarbon service.
 - 6.3.8 Tank farms not within a facility designated as process piping
 - 6.3.9 Air Fueling Terminals.
 - 6.4 The following piping systems, in gas or multi-phase (gas and liquid) service shall be designated as transportation piping systems and shall comply with ASME B31.8 as a minimum:
 - 6.4.1 Cross country pipelines in gas service.
 - 6.4.2 Flowlines, testlines and trunklines in gas or crude oil service.
 - 6.4.3 Gas compression stations in a dedicated facility and not within the plot limit of a process piping facility.
 - 6.4.4 Offshore and sub-sea flowlines and pipelines.
 - 6.4.5 Piping systems on an offshore tie-in platforms and unmanned production platforms.
 - 6.4.6 Liquid sulfur transportation pipelines.
 - 6.4.7 Cross country pipelines in crude oil service having a Reid Vapor Pressure (RVP) more than 1035 Kpa (150 psig).
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- 6.5 Shop fabricated skid mounted piping, such as metering skids, shall follow the applicable Code selected for the facilities to which it will be installed.

7 Applicable Saudi Aramco Standards

- 7.1 The SAES-L series of the piping standards are structured in the format outlined in Table 1.
- 7.2 All pressure piping system, within the scope of this standard, shall be designed and constructed per the applicable SAES assigned in Table 2.
- 7.3 All pressure piping system, within the scope of this standard, shall comply with the standards listed in Table 3:

Table 1 – Numbering Structure of Piping Standards L-Series

SAES-L-Series	Scope/Coverage	Applicable ASME Code	Examples
100	Pressure piping within the scope of SAES-L-100	Any of B31.1, B31.3, B31.4 or B31.8	Refineries, bulk plant, cross country pipeline or flowlines
300	Plant Piping: Pressure piping within a designated plant area	Any of B31.1, B31.3, B31.4 or B31.8	Refineries, bulk plant, tank farm or pump station.
400	Onshore pipelines	B31.4 and or B31.8	QRT's (Qatif to Ras Tanura) pipelines
600	Non metallic piping	Any of B31.3, B31.4 or B31.8	Qurayiah Sea Water Treatment Plant
800	Offshore Piping & Pipelines	B31.3, B31.4 or B31.8	Sub-sea pipelines offshore and production platforms

Table 2 – Applicable Design and Construction Standards for Pressure Piping System

Application	Applicable SAESs for Design	Applicable SAESs for Construction	Examples
Plant piping	SAES-L-310	SAES-L-350	Refineries, bulk plant, pump stations
On land pipelines	SAES-L-410	SAES-L-450	Pipelines in hydrocarbon or other services
Offshore Piping systems	SAES-L-810 SAES-L-850	SAES-L-350	Offshore platform
Sub-sea pipelines	SAES-L-410 SAES-L-850	SAES-L-850	Sub-sea pipelines

Table 3 - Other Applicable L-Series Engineering Standards for Pressure Piping System

Applicable SAES-L Series Standards	Scope of Application
101	Material procurement for line pipes, fittings and gaskets
102	Material procurement for valves
105	Material specifications and line class designations
108	Valves selections and material limitations
109	Selection and limitations on flanges, bolts and gaskets
110	Limitations on piping joints and components
120	Flexibility analysis and pipe supports
125	Safety Instructions Sheet for piping systems
130	Materials requirements for piping in low temperature service
131	Fracture toughness requirements for line pipe
132	Basic material selection for piping systems
133	Corrosion aspects in piping systems
136	Limitations on Carbon Steel line pipe
140	Relief requirements for piping system subject to sun radiation
150	Pressure testing of piping systems
420	Scraper Trap Station Piping and Appurtenances
440	Anchor design for buried cross onshore pipelines
460	Traffic load on line pipes at road crossings and effects of dead weight
610	Non-metallic pressure piping systems

8 Code Break and Plot Limits

- 8.1 The code break shall be defined and well established at the early stage of the piping systems design. If the code break location is not identified according to paragraph 8.4 of this standard, safety, practicality and economical impacts should be always the prime justifications for selecting the physical location.
- 8.2 Existing code breaks should not be altered to meet new requirements or to match newly assigned code breaks within specific facilities. Any changes to the existing code breaks shall be approved jointly by the Piping Standards Committee Chairman, Proponent Representative, Loss Prevention, PMT and CSD through a letter of understanding.
- 8.3 In all cases, the Code break boundary between Codes shall be on the side of the more stringent Code resulting in the higher pipe class.

- 8.4 The following are recommended locations for code break:
 - 8.4.1 Plot limits boundary, preferably the plot limit valve.
 - 8.4.2 Emergency isolation valves located in the vicinity of the perimeter fence.
 - 8.4.3 The isolation valve on the lateral line of an onshore scraper launcher receiver trap.
 - 8.4.4 For Offshore piping code boundaries:
 - a) The first flanged joint on the riser above the water level is considered the break point between piping codes ASME B31.3 and ASME B31.4/ASME B31.8.
 - b) Where a drop-out spool is installed above the riser, the break point shall be the drop-in spool upper flange.
 - c) Piping systems designed for instrument scraping capabilities, the ASME B31.4 or B31.8 Code of the pipeline shall be extended to the launcher / receiver barrel.

9 General Design Basis

- 9.1 It is the responsibility of the Design Agency, who is designing the piping systems for Saudi Aramco, to identify the applicable design parameters.
- 9.2 Each piping system shall be designed to the most realistic condition in order to make the constructed facility cost effective.
- 9.3 Piping systems shall not be design for double contingency unless the possibility for that to occur based on HAZOP studies. The following are examples, but not limited to, of the Contingent Design Conditions:
 - a) Uncontrolled shutdown of plants, including power failure and activation of emergency shutdown (ESD) systems.
 - b) Improper operation due to a single act or operating decision, such as the inadvertent closure of a valve, disregarding an alarm, or disabling a protective device.
 - c) Failure of a single device or function and any chain of events following a single failure.
 - d) The occurrence of fire in fire hazardous areas.
 - e) Ambient conditions such as storms which have an expected average return interval of less than 100 years.

- f) Coincident unrelated contingencies or failures of more than one device shall be considered when so specified in the SAES for specific circumstances (such as in populated areas).
- 9.4 The general Saudi Aramco philosophy for protection piping system is that the piping system shall be mechanically capable to withstand design condition within the applicable Code requirements.
- 9.5 Application of High Integrity Protection Systems (HIPS) shall be per SAES-L-310 or SAES-L-410 as applicable.
- 9.6 The following piping systems are considered **Critical Piping or Equipment**:
 - a) It is part of a vital plant as defined in SAES-O-100.
 - b) It is essential for the operation of the plant at design capacity.
 - c) It cannot be replaced readily using materials from local stocks.
 - d) It is vulnerable to damage from fire or explosion.
 - e) It is in hydrocarbon service except lube oil and seal oil.

Revision Summary

18 November 2006 Major revision to section 9 addressing HIPS applications.