Engineering Standard

SAES-B-064 7 May 2006

Onshore and Nearshore Pipeline Safety

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Revised paragraphs are indicated in the right margin

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1 Scope

1.1 This Standard covers minimum mandatory safety requirements for the design and installation of onshore pipelines and submarine pipelines nearshore (0.5 km or less from the shoreline). These include, but are not limited to, cross-country transportation pipelines, flowlines, trunklines, tielines, water injection lines, gas lift lines, gas injection lines, and test lines.

1.2 The requirements of ASME B31.4 and ASME B31.8 are incorporated into this Standard by reference and shall be applied to pipelines within the scope of this Standard.

1.3 This Standard does not apply to in-plant piping or offshore pipelines.

2 Conflicts and Deviations

2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Saudi Aramco Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Loss Prevention Department of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from the Standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Loss Prevention Department of Saudi Aramco, Dhahran.

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 referenced Specifications, Standards, Codes, Forms, Drawings, and similar material (including all revisions, addenda, and supplements) unless stated otherwise. These references are part of this Standard to the extent specified in the text.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-302	*Instruction for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*
SAEP-310	*Pipeline Repair and Maintenance*

Saudi Aramco Engineering Standards

SAES-J-605	*Surge Relief Protection*
SAES-L-410	*Design of Pipelines*
SAES-L-420	*Scraper Trap Station Piping and Appurtenances*
SAES-L-450	*Construction of On-Land and Near-Shore Pipelines*
SAES-L-460	*Pipeline Crossings Under Roads and Railroads*
SAES-M-006	*Saudi Aramco Security and General Purpose Fencing*
SAES-P-104	*Wiring Methods and Materials*
SAES-P-107	*Overhead Distribution Systems*
SAES-T-911	*Telecommunications Conduit System Design*
SAES-T-928	*Telecommunications – Outside Plant Direct Burial*
SAES-T-621	*Communications Pole Lines*
SAES-X-400	*Cathodic Protection of Buried Pipelines*

Saudi Aramco Standard Drawing

AA-036675	*Cathodic Protection Direct Buried Cable Installation Details*

3.3 Industry Codes and Standards

American Society of Mechanical Engineers

ASME B31.4	*Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols*
ASME B31.8	*Gas Transmission and Distribution Piping Systems*

Institute of Electrical and Electronics Engineers

IEEE STD 80	*Guide for Safety in AC Substation Grounding*

4 Definitions

Corridor: A pipeline corridor is an exclusive land use area for pipeline-related activities.

Emergency Isolation Valve (EIV): Emergency isolation valves are stop flow valves that are installed in a pipeline to isolate the pipeline during an emergency such as a leak or fire. These valves are strategically located to help protect populated areas. See Section 8 for more information.

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

Location Class: Location class is a geographic area along the pipeline classified according to the number of buildings intended for human occupancy.

Lower Flammable Limit (LFL): In the case of gas or vapor that forms a flammable mixture with air, the lower flammable limit is the minimum concentration of the fuel below which propagation of a flame does not occur in the presence of an ignition source. In popular terms, the LFL is too "lean" to burn.

Primary Highway: A controlled-access highway designated as "Primary" by the Ministry of Transport. A Primary highway connects urban areas of 100,000 or more, connects multiple regions, and serves international connections.

Right-of-Way: A legal right of passage through another person's land for a road, a railroad, or a utility such as a power, water, or communications.

Rupture Exposure Radius (RER):

1) For toxic effects, the rupture exposure radius refers to the horizontal distance from a leak source to a 100 parts per million (ppm) level of hydrogen sulfide (H_2S) concentration.
2) For a flammable gas hazard, the rupture exposure radius refers to the horizontal distance from a leak source to the ½ lower flammable limit (LFL).
3) For the purposes of this Standard, the RER is not a population exclusion zone. Rather, buildings within the RER are counted to determine location class. Location class is used to justify an increase in pipeline design safeguards such as fencing, thicker pipe wall, and isolation valves.

Secondary Highway: A highway designated as "Secondary" by the Ministry of Transport. A secondary highway may or may not have controlled-access, connects urban areas of 50,000 or more, connects 2 regions, and may or may not serve international connections.

Sectionalizing Valve: Sectionalizing valves are stop flow valves that are installed to divide a pipeline into shorter sections. They are also installed upstream and downstream of environmentally sensitive areas as identified in the environmental assessment. These valves are provided at specific intervals along the entire pipeline. See SAES-L-410 for more details.

Trunklines: A pipeline to which two or more production flowlines are connected. Normally used upstream of a GOSP or gas plant to collect produced crude oil and natural gas from production wells.

5 General Requirements

5.1 Mechanical design of pipelines shall meet SAES-L-410.

5.2 No pipeline having a diameter of greater than 24 inches shall be permitted within 1000 m of a hospital, school, university, prison, hotel, shopping mall or similar shopping complex, or gathering hall such as a hall for weddings.

5.3 The land around liquids pipelines located nearby industrial, commercial, residential area, roads, bridges, flyovers, or other structures shall be graded or bermed so that any spillage from a rupture shall drain away from the pipeline itself and away from those places and structures.

5.4 Pipeline location class shall be used for the design of both liquid and gas pipelines within the scopes of ASME B31.4 and ASME B31.8. Location class shall be based on the population density index within the rupture exposure radius (RER) along the pipeline route.

5.4.1 For the purpose of this Standard, the RER is the downwind dispersion distance at ground level of a full bore rupture to the limit of 100 ppm H_2S or ½ the lower flammable limit (LFL) of the released vapor, whichever distance is greater. See Table 1 and Table 2 for default RER values.

Pipelines carrying only liquid hydrocarbons with a true vapor pressure (TVP) less than 100 kPa gauge (14.5 psig) at 38°C, and an H_2S concentration of less than 1.5 mole percent shall have the RER as shown in Table 1. For the purposes of this Standard, the RER used for determination of location class shall not be less than Table 1.

Pipelines carrying combustible gas or liquid hydrocarbons with a true vapor pressure equal to or greater than 100 kPa (14.5 psig) at 38°C shall have an RER as shown in Table 2. Calculation by the Loss Prevention Department is required to reduce the RER below the values shown in Table 2.

5.4.2 RERs, for the purpose of determining location class, need not be greater than the values specified in Tables 1 or 2.

Table 1 – Pipeline RER Summary, Low TVP [1]

Pipeline Contents	Pipeline Diameter (in.)	H_2S Mole %	RER (m)	RER Calculated by LPD
Sweet, Low TVP, & Liquid Only	≤ 24	<1.5%	200	Not Required
	>24	<1.5%	400	Not Required

Note: [1] True Vapor Pressure < 100 kPa at 38°C.

Table 2 – Pipeline RER Summary, High TVP [1] or Gas

Pipeline Contents	Pipeline Diameter (in.)	H_2S Mole %	RER (m)
Liquid or Gas	≤ 24	<1.5%	1000 [2]
	≤ 24	≥ 1.5%	3000 [2]
	>24	<1.5%	2000 [2]
	>24	≥ 1.5%	5000 [2]

Notes:

[1] True Vapor Pressure >= 100 kPa at 38°C.

[2] See 5.4.3.

5.4.3 Calculation by the Loss Prevention Department is required to reduce the RER below this value. Submit a written request to perform a calculation based upon the pipeline diameter, fluid composition and temperature, and the maximum shut-in pressure to the Chief Fire Prevention Engineer. Although a calculation is not required if the default RER values are used, in many situations an RER may reduce the design wall thickness requirement and number of emergency isolation valves required. RERs, for the purpose of pipeline design, need not be greater than the values specified in Table 2.

5.4.4 To determine the density index for a pipeline, establish a zone one RER wide to each side of the pipeline. Divide the pipeline and associated RER zone into 1 km long segments. Count the number of buildings and equivalent buildings in each of the segments. This whole number count is the existing one-kilometer density index for the segment.

5.4.5 Buildings having more than four occupied stories shall be included in the density index as a number of equivalent buildings. The number of equivalent buildings shall be calculated by dividing the number of stories in those buildings by three and rounding up to a whole number.

5.4.6 Temporary facilities which will be in place for less than six consecutive months shall be reviewed case-by-case and may be ignored in population

density calculations if concurrence is obtained from the Saudi Aramco Chief Fire Prevention Engineer.

5.4.7 Pipelines shall be designed for the following location classifications based on the above population index determination:

Class 1: Class 1 locations are undeveloped areas within the RER for which the population density index for any 1 kilometer segment is 10 or less.

Class 2: Class 2 locations are areas within the RER for which the population density index is 11 through 30 or pipeline sections adjacent or crossing primary or secondary highways as defined by the Saudi Arab Government Ministry of Transport (see clarifications below). Location Class 2 shall extend 500 meters or the RER distance, whichever is less, from the edge of the highway right-of-way.

Class 3: Class 3 locations are areas within the RER for which the population density index is more than 30.

Class 4: Class 4 locations are areas within the RER in which a school, hospital, hotel, prison, shopping mall or similar retail complex, or wedding hall is located, as well as any Location Class 3 areas which include buildings of more than four occupied floors.

5.4.8 Location Class 2 Clarifications:

a) Location Class 2 piping design for highway crossings need not extend beyond 500 meters from the edge of a highway right-of-way even if the actual RER is greater than 500 m.

b) For pipelines adjacent to or crossing highways that are in populated areas, the more conservative classification shall prevail.

c) The portion of subsea nearshore pipelines located between Lowest Astronomical Tide (LAT) and points 0.4 kilometer on the seaward side of the LAT-line shall be designated for Location Class 2. Location Class 2 shall be the minimum used for the portion of these pipelines located between LAT-line and the onshore anchor.

5.4.9 The extent of RER zones, the boundaries between location class areas, and the location class designation shall be marked on plan drawings. Additionally, the population density index for each kilometer of pipeline shall be provided on a listing in all pipeline project proposals.

5.5 Pipelines shall be inspected for the effects of corrosion and erosion at a frequency to be determined by the Proponent Operating and Inspection Departments. Records of maintenance and replacement shall be kept available for inspection. Repair and maintenance of onshore pipelines shall meet SAEP-310.

5.6 The boundaries of areas in which development is present or planned within the RER of the pipeline shall be indicated on drawings that are maintained by the Land and Lease Division of the Saudi Aramco Government Affairs Organization. Approval for use of land within the RER shall be processed by the Facilities Planning Department. No Saudi Aramco-controlled land shall be developed or released for development unless the requirements of this Standard are met. Land outside a pipeline corridor, but within 500 meters of either side of that pipeline corridor shall not be released except for use for roads, railways, pipelines, electrical powerlines, communication towers, communication cables and other utilities that do not present a significant hazard to the pipelines within the corridor.

6 Appurtenances

6.1 Surge relief protection systems shall be in accordance with SAES-J-605, Surge Relief Protection.

6.2 Scraper Launcher and Receiver Installations

All pipelines passing through location Class 3 or 4 zones shall have appropriate connections for permanent scraper launchers and receivers, installed in accordance with SAES-L-420.

Exception for Class 3 zones:

Scraper connections are not required on flowlines, test lines, dry gas lift lines, GOSP water disposal laterals (not headers), and water injection lines and supply lines.

6.3 Pressure Relief Stations

Pressure Relief and Surge Relief Protection Stations, Flares, Burn Pits, and similar pipeline appurtenances shall be studied on a case-by-case basis to determine minimum spacing from roads, unrelated facilities, and other private or public entities. The study shall include toxic gas dispersion analysis and potential radiation if ignited. Location of these types of facilities shall be approved by the Chief Fire Prevention Engineer or his representative. The spacing shall not be less than 100 m.

7 Pipeline Corridors

7.1 A pipeline corridor constitutes an exclusive land use area for pipeline-related activities; no other uses are allowed, except as specifically addressed in this Standard.

Commentary Note:

Powerlines, communications cables, and pipelines sometimes share or cross the pipeline corridors. If there is no violation of the following requirements, no waiver to SAES-B-064 is necessary.

7.2 With concurrence of the pipeline Operating Department, pipeline corridors may be used for Saudi Aramco communications cables placed parallel to the pipeline when this is the most economical alternative for cable routing. Non-Saudi Aramco communications cables are not allowed within the corridor except for crossings (see 7.8).

7.3 All pipelines shall be placed in designated corridors, which are a minimum of 60 m wide.

Exception:

For (and only for) flowlines, trunklines, test lines, gas lift lines, water injection and supply lines, and GOSP water disposal lines with pipe diameters of 24 inches and less, the minimum corridor width shall be 6.5 meters.

7.4 The minimum clear space between any pipeline and the corridor boundary shall be 30 m.

Exception:

For pipelines designated in the exception to 7.3, the minimum clear space between any pipeline and the corridor boundary shall be 1 m.

7.5 Design, construction, and spacing of parallel pipelines shall meet SAES-L-410 and SAES-L-450.

7.6 Overhead Electrical Powerline Crossings

7.6.1 Where pipeline and overhead powerline corridors cross, the horizontal angle of intersection between the pipeline and powerlines operating in excess of 69 kV should be between 45 to 135 degrees (as measured from the pipeline axis). If the angle is within the limit, no induced voltage study is required. In cases where the angle requirement cannot be met, the Electrical Unit/Consulting Services Department shall verify that the induced-voltage requirements of paragraph 7.6.5 are met. If the induced voltage is within allowable limits of 12 volts per 7.6.5, no further action

or authorization to proceed is required other than to meet the minimum spacing requirements of Table 3.

Commentary Note:

Overhead powerlines that are 69 kV and below do not create a touch potential hazard above the allowable limits.

7.6.2 Where pipeline and overhead powerline corridors cross, the minimum horizontal separation between any pipeline and the poles or structures of overhead powerlines shall be 30 m for powerlines operating in excess of 69 kV.

7.6.3 Where pipeline and overhead powerline corridors cross, the minimum horizontal separation between any pipeline and the poles or support structures of overhead powerlines shall be:

a) 30 m for powerlines operating in excess of 69 kV;

b) 15 m for powerlines operating at 69 kV or less and having only one or two poles near a pipeline;

c) 4.5 m in producing areas for flowlines, trunklines, test lines, gas lift lines, gas injection lines, water injection, supply lines, and disposal lines with pipe diameters of 24 inches and less.

7.6.4 The horizontal spacing between a pipeline and a parallel overhead powerline shall not be less than shown in Table 3.

7.6.5 Induced voltages in pipelines and communications cables shall not exceed twelve (12) volts under normal (i.e., steady-state) conditions. Under fault conditions, induced voltages shall not exceed the values calculated from formulas in IEEE STD 80. Need for an analysis of normal and transient voltages shall be determined by Consulting Services Department for powerlines above 69 kV. For other safety-related requirements during maintenance, refer to SAEP-310.

7.6.6 The minimum vertical clearance (measured from grade) of overhead powerline conductors at pipeline crossings shall be 9.0 m for powerlines operating at 230 kV or less, and 13.5 m for powerlines operating at over 230 kV. For other powerline requirements, see SAES-P-107.

Table 3 – Minimum Horizontal Spacing Between Pipeline and Parallel Overhead Powerline

Powerline Voltage	Minimum Horizontal Spacing from Pipeline
For any voltage less than 69 kV, parallel for more than 1.6 km (1 mile):	30 m
For any voltage 69 kV and greater, parallel for more than 1.6 km (1 mile):	150 m
Up to 230 kV, parallel for less than 1.6 km:	30 m
Up to 500 kV, parallel for less than 1.6 km:	50 m
Up to 1000 kV, parallel for less than 1.6 km:	85 m

7.7 Overhead Communications Cable Crossings

Overhead pole line communications cables, whether Saudi Aramco or non-Saudi Aramco, crossing pipeline corridors shall comply with SAES-T-621. The minimum separation between any pipeline and pole, structure, or cable shall be 15 m horizontal and 9.0 m vertical (measured from grade).

7.8 Underground Electrical and Communications Cable Crossings

7.8.1 Where pre-existing buried electrical and communications cables and associated utilities are encountered as a new pipeline corridor is being created, the crossing shall meet Section 4.5.9, SAES-T-911 for communications cables; Section 10, SAES-P-104 for electrical cables; and the requirements of this Standard.

7.8.2 Underground electrical and communications cables that cross a pre-existing pipeline corridor shall meet the following requirements:

a) Communications cables that cross a pipeline corridor shall meet SAES-T-911 and SAES-T-928.

b) Electrical cables that cross a pipeline corridor shall be installed at least 1 meter under the pipelines in duct banks per SAES-P-104.

c) Cable crossings shall be continuous and at the same elevation with respect to the natural grade across the entire width of the pipeline corridor.

Exception:

If approved by the Proponent and Engineering Support Organizations, low voltage buried powerline cables that are incidental to the pipeline installation and operation, i.e., power, control, and signal cables to emergency isolation valve actuators, can be installed crossing above

pipelines. They shall be marked and protected as required by SAES-P-104.

7.8.3 Non-Saudi Aramco electrical and communications cables shall have no servicing points within pipeline corridors.

7.8.4 For Saudi Aramco electrical and communications cables, no portion of the service point (manhole/vault) for Saudi Aramco shall be closer than 25 m to any pipeline in the corridor.

7.8.5 Saudi Aramco cathodic protection cables crossing pipeline corridors shall comply with SAES-X-400 and Standard Drawing AA-036675.

7.9 Third Party Underground Pipeline Crossings

Non-Saudi Aramco pipelines crossing pipeline corridors shall pass under the pipelines in a manner such that the minimum vertical clearance between the bottom of any Saudi Aramco pipeline and the top of the non-Saudi Aramco piping is 0.5 m. The non-Saudi Aramco piping shall have no servicing points within Saudi Aramco pipeline corridors.

7.10 Road and Railroad Right-of-Way

a) When pipelines cross under roads or railroads through box culverts, the minimum spacing between any two pipes shall be twice the diameter of the larger pipe. The minimum spacing between any pipe and the overhead or side portion of the culvert structure shall be 1.5 pipe diameters, but in no case less than 1 m. See SAES-L-460 for additional requirements.

b) The transition from pipeline spacing within corridors and that stipulated at box culverts shall be made within the road or railroad right-of-way.

7.11 The need for fencing and associated signposting of pipeline corridors shall be determined by the Proponent Operating Department. Where required, fencing shall be constructed in accordance with SAES-M-006 (Type V), with gate locations determined by the Proponent Operating Department.

8 Emergency Isolation Valves

Pipelines, whether in liquid service per the scope of ASME B31.4 or in gas service per the scope of ASME B31.8, shall apply the isolation requirements of ASME B31.8 and the following requirements.

8.1 Emergency isolation valves shall be located as required by the following subparagraphs:

8.1.1 Emergency isolation valves shall be installed between pipeline sections of different location classes defined in ASME B31.8 as specified below:

Location Class 1 and Class 3

Location Class 1 and Class 4

Location Class 2 and Class 3

Location Class 2 and Class 4

Location Class 3 and Class 4

Exception:

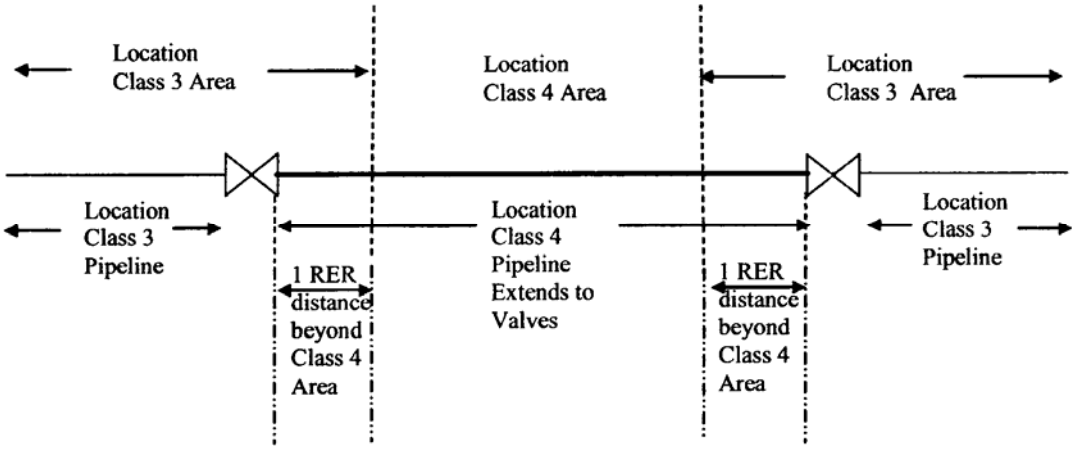
For pipelines designated in the exception to 7.3, emergency isolation valves are not required between location Class 1 and Class 3 or between location Class 2 and Class 3.

8.1.2 Each required emergency isolation valve shall be installed within the lower location class at least the RER distance beyond the class boundary. The higher wall thickness piping shall extend to the valve.

8.1.3 Where an emergency isolation valve is required, a change in ASME location class design can be made only at the emergency isolation valve.

8.1.4 The extension of a pipeline section of higher strength ASME location class design into a lower location class area beyond the required RER distance is permissible to minimize the number of emergency isolation valves.

Figure 1 – Illustration of 8.1.2 and 8.1.3



8.2 The emergency isolation valves for location Class 3 and Class 4 areas shall be fitted with remote pipeline pressure monitoring and shall have remote closure activation capability from a manned control facility.

8.3 A sectionalizing block valve (see SAES-L-410 for requirements) can be used as an emergency isolation valve also if the valve complies with the requirements of this Standard.

8.4 The emergency isolation valve closure rate shall be determined by the pipeline's surge characteristics, but total closing time shall not exceed 10 minutes.

Revision Summary

28 September 2005	Major revision.
7 May 2006	Editorial revision.