

# Engineering Standard

SAES-B-057

29 June, 2005

## Safety Requirements: Refrigerated and Pressure Storage Tanks and Vessels

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## Saudi Aramco DeskTop Standards

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## 1 Scope

This Standard defines the minimum mandatory safety requirements governing the design and installation of offsite refrigerated and pressure storage tanks and vessels located onshore and above grade, which typically store liquefied ethane, natural gas liquids (NGL), or liquefied petroleum gases (LPG), including the following:

- 1.1 Low-pressure dome roof tanks used for the storage of refrigerated, liquefied gases up to 17 kPa<sub>(ga)</sub> (2.5 psig) design pressure, per [SAES-D-100](#).
- 1.2 Spheres and spheroids used for the storage of flammable materials at pressures in excess of 69 kPa<sub>(ga)</sub> (10 psig) design pressure, per [SAES-D-001](#).
- 1.3 Horizontal pressure vessels used for the storage of flammable materials at pressures in excess of 69 kPa<sub>(ga)</sub> (10 psig) design pressure, per [SAES-D-001](#).

This standard does not apply to tanks or vessels that are part of a process unit.

## 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, Loss Prevention Department 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 of the 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 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

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<a href="#"><u>SAES-B-005</u></a>	<i>Spacing and Diking For Atmospheric and Low-Pressure Tanks</i>
<a href="#"><u>SAES-B-006</u></a>	<i>Fireproofing for Plants</i>
<a href="#"><u>SAES-B-017</u></a>	<i>Fire Water System Design</i>
<a href="#"><u>SAES-B-18</u></a>	<i>Air Foam Systems for Storage Tanks</i>
<a href="#"><u>SAES-B-054</u></a>	<i>Access, Egress, and Materials Handling for Plant Facilities</i>
<a href="#"><u>SAES-B-055</u></a>	<i>Plant Layout</i>
<a href="#"><u>SAES-B-058</u></a>	<i>Emergency Isolation, Shutdown, And Depressuring</i>
<a href="#"><u>SAES-B-068</u></a>	<i>Electrical Area Classification</i>
<a href="#"><u>SAES-B-070</u></a>	<i>Bulk Plants, Air Fueling, and Sulfur Loading Facilities</i>
<a href="#"><u>SAES-D-001</u></a>	<i>Design Criteria of Pressure Vessels</i>
<a href="#"><u>SAES-D-100</u></a>	<i>Design Criteria of Atmospheric and Low-Pressure Tanks</i>
<a href="#"><u>SAES-J-300</u></a>	<i>Level</i>
<a href="#"><u>SAES-J-505</u></a>	<i>Combustible Gas and Hydrogen Sulfide in Air Detection Systems</i>
<a href="#"><u>SAES-J-600</u></a>	<i>Pressure Relief Devices</i>
<a href="#"><u>SAES-L-108</u></a>	<i>Selection of Valves</i>
<a href="#"><u>SAES-L-310</u></a>	<i>Design of Plant Piping</i>
<a href="#"><u>SAES-S-020</u></a>	<i>Industrial Drainage and Sewers</i>

### 3.2 Industry Codes and Standards

#### American Petroleum Institute

<i>API RP 2003</i>	<i>Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents</i>
<i>API STD 2510</i>	<i>Design and Construction of LP-Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries, and Tank Farms</i>
<i>API PUB 2510A</i>	<i>Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities</i>

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## 4 Definitions

**High-Pressure Tank or Vessel:** A tank or vessel that is within the scope of [SAES-D-001](#).

**Low-Pressure Tank:** A tank that is within the scope of [SAES-D-100](#).

**Offsite:** Equipment, structures, or buildings are considered offsite as long as they are located outside the plot-limit of the process unit, regardless of whether they are inside or outside the plant security perimeter fence. Offsite spacing requirements per [SAES-B-055](#), Figure 2 show the minimum spacing distances required between process areas and other typically separate equipment, structures, or buildings.

**Onsite:** Onsite requirements per [SAES-B-055](#), Figure 1, are for spacing equipment within a facility process unit where distance between **individual** equipment is considered to be important to reduce property loss in the event of a fire. Onsite fire protection requirements for equipment within process areas are found in [SAES-B-017](#).

**Offsite Refrigerated and Pressure Storage Tanks and Vessels:** Tanks and vessels located offsite per Appendix 2 in [SAES-B-055](#).

**Single-Containment Refrigerated Storage Tank:** A storage tank consisting of one or two shells, but having only one shell designed for containment of the full head of stored product at minimum temperature.

**Shutoff valve:** A hand operated valve (unless otherwise specified) on a vessel connection that can stop flow.

## 5 General Requirements

- 5.1 High-pressure and low-pressure storage tanks and vessels shall be designed and installed in accordance with API STD 2510 and API PUB 2510A except as modified by this Standard and with [SAES-D-001](#) or [SAES-D-100](#), as applicable.
  - 5.2 Fireproofing and insulation systems used as fireproofing for tank, vessels, and piping supports shall meet the requirements of [SAES-B-006](#). Tank and vessel shells do not require fireproofing.
  - 5.3 A fixed deluge system, with a supplemental spray ring for protection of the vessel under the legs, shall be provided to protect spheres, spheroids, hemispheroids, and domed roof tanks containing flammable liquids. See [SAES-B-017](#) for more deluge system design details.
  - 5.4 Electrical area classification shall meet the requirements of [SAES-B-068](#).
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- 5.5 Combustible gas detection shall be provided within the diked area of refrigerated and pressure storage tanks and vessels. The gas detection system shall meet [SAES-J-505](#).
  - 5.6 Water Flood Connection
    - 5.6.1 A water flood connection shall be provided for spheres in non-refrigerated service to permit flooding of the tank with water per API 2510.
    - 5.6.2 The water flood connection shall be provided either into the vapor space of the tank or directly into the product line to the bottom of the tank (between the EIV and the tank).
    - 5.6.3 In applications where hydrate formation is likely, the possibility of freezing shall be considered in the design.
    - 5.6.4 The water flood connection shall extend outside the spill containment dike and shall include (in physical order) a block valve, a plugged drain valve, a check valve, and two 2½-inch fire hose connections with vented caps.
    - 5.6.5 A permanent sign shall be posted at the hose connections indicating the injection pressure required to pump water into the sphere.
    - 5.6.6 A written procedure detailing the use of the water flood connection shall be approved by the Proponent Operating Department, the Area Fire Marshall, and the Chief Fire Prevention Engineer.
  - 5.7 Protection against ignitions arising out of static, lightning, and stray currents shall meet API RP 2003.
  - 5.8 Piping design shall meet [SAES-L-310](#). Within diked areas, tank filling and discharge piping shall be designed to minimize or eliminate flanged connections.
  - 5.9 Sample and Water Draw-off Connections
    - 5.9.1 The outlet of a sample connection (blow-off to atmosphere) or water draw-off connection shall not be located beneath nor within 3 m (10 ft) of tank's shadow.
    - 5.9.2 Water draw and sampling connections shall be made of adequately supported and braced solid piping. Thin-wall tubing and flexible hose are not acceptable.
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- 5.9.3 Water draw and sampling connections shall be double-valved with both valves located at the operator's position. The valves shall be separated by no less than 1 m. The upstream valve shall be a quick-action type, such as a metal-seated plug valve. In addition to double valving at the operator's position, a root isolation valve shall be provided on the tank shell nozzle or boss. The root valve shall have a spring-return type actuator with a fusible link for automatic closure.
- 5.9.4 A water drain shall discharge at a point not less than 4.5 m (15 ft) beyond the shadow of the storage tank. The discharge shall be run to a sealed catch basin (see [SAES-S-020](#)) or otherwise be so located that any flammable spillage will drain away from the tank to a safe location.

## 6 Layout and Spacing

- 6.1 Storage tanks and vessels shall be located to permit the maximum dissipation of vapors by free circulation of air. The minimum spacing between tanks specified below shall be measured shell-to-shell.
  - 6.2 Tanks and vessels shall be arranged such that there are no more than two rows of vessels between roads or accessways. Every tank and vessel shall be adjacent to a road or accessway. Emergency response vehicle access shall be possible from two directions.
  - 6.3 Manifolds, piping (except that associated with the tank or vessel), and process related equipment such as pumps shall be located outside the diked area and at least 7.5 m (25 ft) from the dike wall. Spacing shall otherwise meet [SAES-B-055](#).
  - 6.4 Refrigerated Storage Tanks
    - 6.4.1 Domed-roof refrigerated tanks shall be located a minimum of one diameter, but in no case less than 30 m (100 ft), from each other or from high-pressure storage facilities.
    - 6.4.2 Dome-roof refrigerated tanks shall be no less than 60 m (200 ft) from process equipment (including equipment related to the vessel such as shipping pumps), utility plants, or occupied buildings.
  - 6.5 High-pressure Storage Tanks and Vessels
    - 6.5.1 High-pressure storage vessels shall be located  $\frac{3}{4}$  diameter, but in no case less than 30 m (100 ft), from each other.
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- 6.5.2 High-pressure storage vessels shall be located one diameter of the largest tank, but in no case less than 30 m (100 ft), from flammable or combustible liquids stored in atmospheric tankage.
- 6.5.3 High-pressure storage tanks and vessels shall be located a minimum of 60 m (200 ft) from all other facilities except related process equipment.
- 6.6 Other layout spacing details shall meet [SAES-B-055](#).

## 7 Diking and Drainage

- 7.1 Low-pressure Refrigerated Storage Tanks
  - 7.1.1 Single-containment refrigerated storage tanks greater than 64 000 m<sup>3</sup> (400 000 bbl) shall be individually diked. Dike capacity shall be 100% of the tank capacity.
  - 7.1.2 For tanks of 64 000 m<sup>3</sup> (400 000 bbl) or less, no more than two tanks are permitted inside a common dike. The common dike must hold at least 100% of the larger tank. An intermediate dike that is 0.3 m (1 ft) lower than the common dike shall be provided between the tanks.
- 7.2 High-pressure storage tanks and vessels shall be individually diked or provided with diversion walls to direct spills to a safe location.
  - 7.2.1 Horizontal vessels larger than 320 m<sup>3</sup> (2000 bbl) shall be individually diked or provided with diversion walls to direct spills to a safe location.
  - 7.2.2 Dike capacity shall be based upon the maximum liquid product anticipated in the event of a spill and shall be sufficient to contain at least 50% of tank capacity for materials having a vapor pressure less than 690 kPa (100 psia) at 38°C (100°F) or 25% of the tank capacity for other materials.

### *Commentary Note:*

*The main intent is to provide protection for a controllable incident such as a partial flange leak, a frozen valve on a water draw, or the loss of a small-diameter piping connection. For these types of incidents the primary concern is to minimize the size of the resultant vapor cloud. Much of the spilled product will flash to vapor immediately. Super-chilled liquid will pool on the ground. Additional vapor cloud generation can best be minimized by minimizing the warm surfaces in contact with the spilled liquid. At the same time, it is desirable to move any resultant liquid out from under the leaking vessel. To do this, dike surfaces should be sloped to move spills away from the tank. Dike areas should be kept as small as possible to minimize surface area. Dike walls should be kept as low as possible to allow maximum wind scour of vapor from small leaks, and to*

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*allow maximum emergency response access in the event of an incident. While trenches are normally prohibited, for LPG storage facilities they may provide the best means of minimizing surface area of spills while directing any flow to the nearest sealed catch basin.*

- 7.3 Surfaces shall be sloped away from the tank, piping, and other equipment to a single point near the dike or diversion wall. The minimum slope shall be 1:65 (1.5%). Dikes shall be designed to be liquid tight and able withstand a full hydrostatic head of water. Drainage in each diked area shall be provided in accordance with [SAES-S-020](#).

## **8 Access for Operation, Maintenance and Firefighting**

- 8.1 Stairways and access platforms shall be provided to allow access to operating valves and instruments per [SAES-B-054](#).
- 8.2 A 6 m (20 ft) wide earthen ramp shall be provided over tank dikes for access of mobile equipment. As an alternative, and provided the Proponent Operating Department concurs, a lift-out section may be provided in the case of a concrete dike wall. Liquid-tight sealing of the lift-out section shall be provided.
- 8.3 Each diked area shall be provided with a total of two stiles located on opposite sides of the diked area if the dike is over 90 cm (36 in) high. These stiles shall be located near fire hydrants.

## **9 Isolation**

- 9.1 Shutoff valves shall be provided at tank connections as specified in API STD 2510. Valves 50 mm (2 in) and larger shall be flanged and shall be suitable for the line service classification.
- 9.2 All shutoff valves located below the maximum liquid level shall be indicating type valves and shall meet fire safety requirements as specified in [SAES-L-108](#). Emergency Isolation Valves (EIVs), where required, shall be listed Class 4 or better.
- 9.3 Storage tank fill and discharge piping connections shall have emergency isolation valves (EIVs) located at the tank nozzles. For information on EIVs, see [SAES-B-058](#).

## **10 Instrumentation**

- 10.1 Level devices shall comply with [SAES-J-300](#). Gauge glasses shall not be used except where required for calibration of other instrumentation. Where installed,

- gauge glasses shall be maintained in a closed and drained condition except when such calibration is being performed.
- 10.2 At least two independent liquid level gauging devices shall be provided for each tank. One of these gauging devices shall be displayed in the manned control house supervising the tank farm.
  - 10.3 An independent high liquid level alarm shall be installed in each tank. The alarm shall be set to allow operating personnel sufficient time to stop incoming flow without overflowing the tank. The use of a high level flow shutoff device shall not nullify the requirement for a high level alarm.
  - 10.4 High- and low-pressure alarms shall be provided for each tank used in refrigerated storage service.
  - 10.5 Alarms shall be distinctive and audible to personnel controlling the filling of the vessel and shall operate independently of any shutoff, shutdown, or gauging device.
  - 10.6 An indicating pressure gauge shall be installed in the top of each tank.
  - 10.7 For refrigerated storage tanks, a low-pressure shutdown shall be provided on compressors of associated refrigeration equipment and on shipping pumps.
  - 10.8 Safety relief valves shall be sized for fire exposure or for operating contingency, whichever is larger. The valve sizing and arrangement shall conform to the applicable provisions of [SAES-J-600](#).
  - 10.9 Vessels not designed to withstand full vacuum shall be provided with vacuum relief valves sized to protect the vessel for the following, regardless of instrumentation installed:
    - a) Maximum withdrawal from vessel.
    - b) Pressure draw down by refrigeration compressors.
    - c) Condensation due to rainfall, or ambient temperature drop.
  - 10.10 With the exception of relief valve piping, all instrument connections (except thermo wells) smaller than 50 mm (2 in) shall be provided with excess flow check valves or restricting orifices having an orifice size not greater than 3.175 mm ( $\frac{1}{8}$  in), or spring return valve with fusible link.

#### Revision Summary

29 June, 2005

Revised the "Next Planned Update". Reaffirmed the contents of the document and reissued with minor changes.

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