



Engineering Standard

SAES-D-109

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Design of Small Tanks

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Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This standard defines the minimum mandatory requirements governing the design and selection of small atmospheric pressure storage tanks used in production, process plant, bulk plant, building services, fuel dispensing, or community facilities applications.
 - 1.1.1 This standard shall not be attached to nor made a part of purchase orders.
 - 1.1.2 The selection and design of field-erected atmospheric pressure storage tanks in accordance with API STD 650, Appendix J shall be in accordance with SAES-D-100.
- 1.2 This standard covers tanks used for the aboveground or underground storage of flammable and combustible liquids up to 1500 barrels capacity. It also covers tanks used for the storage of chemicals and water.
- 1.3 Tanks designed in accordance with this standard shall be limited to a maximum capacity given by the relevant industry standards addressed by this standard..
- 1.4 Only Fiberglass Reinforced Plastic (FRP) material of construction shall be used for buried tanks.
- 1.5 This standard shall be used by the Design Engineer to complete the tank data sheets.

2 Conflicts and Deviations

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

3 References

The selection and design 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-A-005 Safety Instruction Sheets
SAES-A-112 Meteorological Data
*SAES-B-005 Spacing and Diking For Atmospheric and Low-
Pressure Tanks*
*SAES-B-054 Access, Egress, and Materials Handling for Plant
Facilities*
SAES-B-055 Plant Layout
*SAES-D-100 Design Criteria of Atmospheric and Low-Pressure
Tanks*
SAES-H-001 Coating Selection & Application
SAES-H-101 Approved Protective Coating System
SAES-J-300 Level
SAES-N-001 Insulation
SAES-P-111 Grounding
SAES-Q-005 Concrete Foundations
SAES-X-500 Cathodic Protection of Vessels and Tank Internals
SAES-X-600 Cathodic Protection of Plant Facilities

Saudi Aramco Materials System Specification

32-SAMSS-030 Manufacture of Small Tanks

Saudi Aramco Standard Drawings

AB-036003 Manholes and Vents for Tanks
AD-036061 Roof Center Vents for Cone-Roof Tanks
*AA-036355 Impressed Current Tank Bottom, Cathodic
Protection Details*
AB-036387 Grounding

Saudi Aramco Forms and Data Sheets

<i>Form SA 2693-ENG</i>	<i>Tank Safety Instruction Sheet</i>
<i>Form SA 2696-ENG</i>	<i>Appurtenance Schedule and Orientations</i>

3.2 Industry Codes and Standards

American Petroleum Institute

<i>API STD 650</i>	<i>Welded Steel Tanks for Oil Storage</i>
<i>API STD 2000</i>	<i>Venting Atmospheric and Low-Pressure Storage Tanks</i>
<i>API RP 2003</i>	<i>Protection Against Ignitions Arising Out of Static, lightning, and Stray Currents</i>
<i>API SPEC 12F</i>	<i>Specification for Shop Welded Tanks for Storage of Production Liquids</i>
<i>API SPEC 12P</i>	<i>Specification for Fiberglass Reinforced Plastic Tanks</i>

American Society of Mechanical Engineers

<i>ASME RTP-1</i>	<i>Reinforced Thermoset Plastic Corrosion Resistant Equipment</i>
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American Water Works Association

<i>AWWA D100</i>	<i>Welded Steel Tanks for Water Storage</i>
<i>AWWA D120</i>	<i>Thermosetting Fiberglass-Reinforced Plastic Tanks</i>

British Standard

<i>BS 4994</i>	<i>Design and Construction of Vessels and Tanks in Reinforced Plastics</i>
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Underwriters Laboratories, Inc.

<i>UL 142</i>	<i>Steel Aboveground Tanks for Flammable and Combustible Liquids</i>
<i>UL 1316</i>	<i>Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures</i>

4 Definitions

Design Engineer: The Engineering Company responsible for specifying, on the design data sheet, the design requirements for tanks.

Combustible Liquid: A liquid that has a flash point greater than 54°C and that is at a temperature lower than 8°C below its flash point.

Flammable liquid: A liquid that has a flash point equal to or less than 54°C.

Saudi Aramco Engineer: The Supervisor of the Process Equipment Unit, Consulting Services Department, Dhahran.

Small Tanks: Shop fabricated or field erected atmospheric pressure storage tanks up to 1500 barrels capacity.

Tank Manufacturer: The Company responsible for the design and fabrication of tanks.

5 Responsibilities

- 5.1 The Design Engineer is responsible for specifying the type, size and design conditions for storage tanks, including the requirements for associated tank appurtenances.
- 5.2 The Tank Manufacturer is responsible for the design, supply of materials, fabrication, erection, inspection, testing, surface preparation and painting of tanks in accordance with the Design Engineer's specification.

6 Tank Selection

- 6.1 Aboveground steel tanks according to API SPEC 12F, UL 142 or API STD 650, Appendix J shall be used for the storage of crude oil, hydrocarbon intermediates, chemicals, or final products and located within process plants, bulk plants, buildings, fuel dispensing or community facilities. The choice of the appropriate standard shall be based on the following:
 - (1) The size limitation(s) and tank configuration(s) addressed by the standard.
 - (2) The Design Engineer shall use the most economical selection from the standard specified in each case considering operation requirements and compatibility with the intended service
 - 6.2 Buried, fiberglass reinforced plastic tanks to be used for the storage of petroleum products shall be in accordance with UL 1316 and the design rules of ASME RTP-1 or BS 4994.
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- 6.3 Aboveground, vertical, cylindrical, fiberglass reinforced plastic tanks to be used for the storage of petroleum products, alcohol-gasoline mixtures, or corrosive chemicals shall be in accordance with API SPEC 12P.
- 6.4 Aboveground steel tanks to be used for the storage of water shall be in accordance with AWWA D100.
- 6.5 Aboveground fiberglass reinforced plastic tanks to be used for the storage of water shall be in accordance with AWWA D120.
- 6.6 Fiberglass reinforced plastic tanks shall comply with the restrictions of SAES-B-055, Section 8.7 on their use.
- 6.7 Steel tanks used for the storage of flammable or combustible liquids and located within production facilities, process plants, or bulk plants shall be installed aboveground.
- 6.8 Fiberglass reinforced plastic tanks used for the storage of flammable or combustible liquids and located within fuel dispensing or community facilities shall be buried or located underground level.

7 Materials

- 7.1 The Design Engineer shall specify material requirements based on the specific tank service.
- 7.2 The Design Engineer shall specify a corrosion allowance for unlined carbon and low-alloy steel tanks based on the anticipated service life and corrosivity of the liquids to be stored.
- 7.3 Materials proposed by the Tank Manufacturer shall be selected in accordance with 32-SAMSS-030.

8 Design

- 8.1 General
 - 8.1.1 The Design Engineer shall complete the Storage Tank Data Sheet for the tank being purchased in accordance with this standard as follows:
 - (1) API SPEC 12F tanks: Complete the Storage Tank Data Sheet in Appendix I of this standard.
 - (2) API STD 650 Appendix J tanks: Use the Storage Tank Data Sheet in Appendix L of API STD 650 and provide the information as detailed in Appendix II of this standard.
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- (3) UL 142 tanks: Complete the Storage Tank Data Sheet provided in Appendix III of this standard.
- (4) API SPEC 12P tanks: Use Data Sheet 1 of API SPEC 12P and provide the information as detailed in Appendix IV of this standard.
- (5) UL 1316 tanks: Complete the Storage Tank Data Sheet provided in Appendix III of this standard.
- (6) AWWA D100 tanks: Use Section III or Section IV in the Forward of AWWA D100 as applicable and provide the required information.
- (7) AWWA D120 tanks: Complete the Storage Tank Data Sheet as provided in Appendix III of this standard.

8.1.2 The Design Engineer shall complete Form SA 2696-ENG showing the tank dimensions, appurtenance schedules, orientations and elevations.

8.1.3 The Design Engineer shall complete tank Safety Instruction Sheets in accordance with SAES-A-005.

8.2 Design Criteria

Storage tanks within the scope of this standard shall be designed, fabricated, inspected and tested in accordance with the applicable industry standard listed in Paragraph 3.2 of this standard and 32-SAMSS-030.

8.3 Tank Dimensions and Capacity

8.3.1 The Design Engineer shall determine the initial tank dimensions based on the most economical tank height (or length) versus diameter.

8.3.2 The Design Engineer shall verify that the Tank Manufacturer's design proposal meets the specified dimensional requirements.

8.4 Design Conditions

The design temperature shall be the maximum operating temperature of the tank.

8.5 External Loads

8.5.1 The basic wind speed corresponding to the tank site shall be specified in accordance with SAES-A-112.

- 8.5.2 The seismic zone factor, importance factor and the site coefficient corresponding to the tank site shall be specified in accordance with SAES-A-112.
- 8.5.3 Underground tanks shall be designed for soil, traffic and/or buoyancy loads as applicable.
- 8.5.4 Loads superimposed by platforms and brackets and loads resulting from connected piping shall be considered in the tank design.
- 8.6 Under-tank leak detection and sub-grade protection shall be provided for aboveground, vertical flat bottom steel tank supported directly on soil foundation according to paragraph 14.3 of this standard.

9 Appurtenances

9.1 General

The type, quantity and layout of all appurtenances for storage tanks shall be specified in accordance with this standard.

9.2 Nozzles and Manways

- 9.2.1 Nozzle and piping sizes 1- $\frac{1}{4}$ inch, 2- $\frac{1}{2}$ inch, 3- $\frac{1}{2}$ inch and 5 inch NPS shall not be used.
 - 9.2.2 Nozzles 2 inch NPS and larger shall be flanged.
 - 9.2.3 Connections 1- $\frac{1}{2}$ inch NPS and smaller, other than welding outlets and welding bosses, shall be Class 3000 minimum, either socket welded or threaded couplings.
 - 9.2.4 Connections 1- $\frac{1}{2}$ inch NPS and smaller shall be gusseted to prevent potential physical damage during handling and shipping.
 - 9.2.5 Manways for aboveground, vertical cylindrical tanks shall be specified as follows.
 - (1) One 24 inch NPS shell manway.
 - (2) One 20 inch NPS roof manway for tanks larger than 10,000 gallons capacity.
 - (3) A cleanout opening, when provided in accordance with the requirements of the relevant standard or specification, may be substituted for the shell manway.
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9.2.6 One 20 inch NPS manway shall be provided for aboveground or underground horizontal cylindrical tanks.

9.3 Venting

9.3.1 Normal and emergency venting requirements shall be specified in accordance with API STD 2000, SAES-J-600, SASD AB-036003 and AD-036061 and the requirements of this specification.

9.3.2 Maximum filling and emptying rates specified on the Storage Tank Data Sheet shall be used as a basis for determining the normal venting capacity.

9.3.3 All open vents shall be protected by bird screens.

9.3.4 The need to protect fixed roof tanks against internal deflagration shall be determined by the design engineer according to NFPA 68. The design of deflagration venting shall be submitted to the Chief Fire Prevention Engineer and CSD for review.

9.3.5 Provision of frangible joint at the shell-to-roof juncture is prohibited.

9.4 Temperature Instruments

9.4.1 Dial thermometers shall be specified, when required by the Operating Unit at the specific facility. The size and location of thermometers shall be shown on Form SA 2696-ENG.

9.4.2 Tanks with heaters shall be equipped with a self-actuating temperature controller, unless the inlet steam temperature is such that the condensing temperature will not exceed the process needs. The location of the sensing point for the controller shall be the same as for a dial thermometer.

9.5 Level Gauging Systems

9.5.1 Level gauging systems shall be specified in accordance with SAES-J-300.

9.5.2 A minimum of one level gauging instrument per tank, readable either from grade or from an access platform, shall be specified. Radar gauge assembly, if required, shall be in accordance with SASD AA-036256.

9.5.3 Provisions for manual gauging shall be specified, even if the tank is provided with an automatic gauging device.

9.6 Sample Connections

- 9.6.1 Sample connections shall be specified, when required by the Operating Unit at the specific facility.
- 9.6.2 The number, size and location of sample connections shall be shown on Form SA 2696-ENG.
- 9.7 Stairways, Ladders and Platforms
 - 9.7.1 Stairways, ladders and platforms shall be specified in accordance with SAES-B-054.
 - 9.7.2 Access to the roof of aboveground, vertical, cylindrical, tanks shall be provided as follows.
 - (1) A spiral stairway shall be specified for tanks over 6 m in height and for tanks requiring gauging or sampling from the roof. A platform shall also be specified for access to the gauge or sampling hatch.
 - (2) A vertical ladder shall be specified for tanks that do not require spiral stairways.
 - (3) Stairs shall be located on the upwind side with respect to the prevailing wind direction of vertical tanks in hydrocarbon services, and this shall be shown on Form SA 2696-ENG. However, where it is impractical to meet this requirement, only the upper stairway landing is required to be located upwind side of the tank.

10 Coatings and Painting

- 10.1 Surface preparation and painting specifications shall be selected in accordance with SAES-H-001.
- 10.2 The Design Engineer shall specify all painting requirements on the Storage Tank Data Sheet in accordance with SAES-H-101, including the Approved Protective Coating Systems (APCS), surface preparation, primer type, number of coats, total thickness and the areas or parts of the tank to be painted.

11 Insulation

- 11.1 The Design Engineer shall specify the type and thickness of external insulation for above ground tanks in accordance with SAES-N-001, where required.
 - 11.2 The Design Engineer shall specify whether aboveground tanks must be insulated to protect them from fire exposure based on tank location or when required by the Operating Unit.
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12 Grounding

The Design Engineer shall specify the grounding requirements for tanks in accordance with SAES-P-111, API RP 2003 requirements and:

- (1) SASD AB-036387 for vertical tanks
- (2) PIP VEFV1100 for horizontal and rectangular tanks.

13 Cathodic Protection

Cathodic protection requirements shall be in accordance with SAES-X-500 and SAES-X-600.

14 Foundations

- 14.1 Spacing and diking of tanks shall be in accordance with SAES-B-005.
- 14.2 Concrete foundations for tanks shall be in accordance with SAES-Q-005.
- 14.3 Under Tank Leak Detection and Sub-grade Protection
 - 14.3.1 Tanks in services other than water shall be provided with an under tank leak detection and sub-grade protection according to API STD 650, Appendix I. Acceptable construction details are Figures I-1, I-2, I-3, I-8, I-9 and I-10.
 - 14.3.2 Flexible membrane liner of minimum 1000 microns (40 mils) thickness compatible with the stored product shall be specified under the tank bottom. The liner shall be placed according to SASD AA-036355, extending to the internal top edge of the ring foundation.
 - 14.3.3 Joints in the liner shall satisfy the leak tightness, permeability, and chemical resistance requirements for the liner material.
 - 14.3.4 Alternative under-tank leak detection and sub-grade protection systems shall not be permitted without the prior approval of the Saudi Aramco Engineer.

15 Drawings, Calculations, and Data

- 15.1 The Design Engineer shall complete the Storage Tank Data Sheet and forms to the extent specified in this standard.

- 15.2 The Design Engineer is responsible for completion of applicable portions of the Tank Safety Instruction Sheet (Form SA 2693-ENG) in accordance with the data provided by the Tank Manufacturer and SAES-A-005.

4 January 2006

Revision Summary
Major revision.

Appendix I
Data Sheet for Storage Tanks Designed
In Accordance with API SPEC 12F

1. Tank Location:
Name of Plant: _____
Location: _____

 2. Tank No. _____
Nominal Capacity _____ Gallons/Barrels
Outside Diameter _____ m
Height _____ m

 3. Type of Bottom: _____
Flat: _____
Unskirted Cone: _____
Skirted Cone: _____

 4. Corrosion Allowance: _____ mm

 5. Shell Plate Thickness: _____ mm

Specify as 6 mm plus corrosion allowance in excess of 1.6 mm.

 6. Maximum Pumping Rates:
In _____ Barrels/Hour (Gallons/Hour)
Out _____ Barrels/Hour (Gallons/Hour)

 7. Liquid Stored _____ Design S.G. _____ at _____ °C

Is this a viscous oil service?
Yes _____
No _____

 8. Maximum Operating Temperature _____ °C

 9. Wind Velocity _____ km/h(mph)

 10. Earthquake Zone _____
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Appendix I (Continued)

11. No. and Size of Shell Manholes _____
No. and Size of Roof Manholes _____
12. Shell Nozzles:
Inlet: No. _____ Size: _____
Outlet: No. _____ Size _____
13. Instrument Connections:
Level: No. _____ Size _____
Temperature: No. _____ Size _____
Sample: No. _____ Size _____
14. Is an anti-channel drain baffle required?
Yes _____
No _____
15. Is a downcomer pipe required?
Yes _____
No _____
16. Insulation _____
17. Paint _____
Internal Coating _____
18. Stairway: Circular _____
Straight _____

Ladder: _____
19. Purchaser's Reference Documents:
SAMSSs _____
SASDs _____
Forms _____
Others _____
20. Remarks

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Appendix II

Completion of API STD 650 Storage Tank Data Sheet For Appendix J - Shop-Assembled Storage Tanks

The Design Engineer shall complete the following portions of the tank data sheet:

1. Page 1 of Data Sheet
 - (1) All items on Page 1. Add Appendix J to Items 9 and 10.
 - (2) Item 5, the maximum pumping rates must be specified in order to properly size the vents.
 2. Page 2 of Data Sheet
 - (1) Item 8, the details in API STD 650, Figure F-1, showing the horizontal leg of the roof support angle turning inward for cone roof tanks.
 - (2) Item 12, paint in accordance with Paragraph 10 of this standard
 - (3) Item 13, tank bottom coating, if required
 - (4) Item 18, mill test reports shall be required
 - (5) Item 19, applicable Saudi Aramco Standard Drawings and Forms shall be listed
 - (6) Item 21, 32-SAMSS-030 shall also be listed
 3. Page 3 of Data Sheet
 - (1) Item 1, stairway style in accordance with this standard
 - (2) Items 8, 9, 10 and 11, number and size of shell and roof manholes, and shell and roof nozzles, in accordance with completed Form 2696-ENG for the tank.
 - (3) Other accessories, such as level gages, grounding lugs, etc., which are to be supplied by the Tank Manufacturer, shall also be included on the Storage Tank Data Sheet.
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Appendix III
Data Sheet for Storage Tanks Designed
In Accordance with UL 142, UL 1316, or AWWA D120

1. Tank Location: _____
Name of Plant: _____
Location: _____

 2. Applicable Industry Standard:

UL 1316 _____
UL 142 _____ AWWA D120 _____

 4. Tank Material (For UL 142 tanks)

Carbon Steel _____
Stainless Steel _____

 5. Tank No. _____
Nominal Capacity _____ Gallons/Barrels
Diameter _____ m
Height (Length): _____ m

 6. Tank Geometry
Cylindrical: _____
Spherical: _____
Rectangular: _____

 7. Tank Orientation:
Vertical: _____
Horizontal: _____

 8. Maximum Pumping Rates:
In _____ Barrels/Hour (Gallons/Hour)
Out _____ Barrels/Hour (Gallons/Hour)

 9. Liquid Stored _____ Design S.G. _____ at _____ °C
Corrosion Allowance _____ mm

 10. Wind Velocity _____ km/h (mph)
Earthquake Zone _____
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Appendix III (Continued)

Maximum Operating Temperature _____ °C

11. For UL 142 Tanks Only

Is Secondary Containment Required?

Yes _____

No _____

Stairway: Circular _____
 Straight _____

Ladder: _____

12. No. and Size of Manholes _____

13. Shell Nozzles:

Inlet: No. _____ Size _____

Outlet: No. _____ Size _____

14. Instrument Connections:

Level: No. _____ Size _____

Temperature: No. _____ Size _____

Sample: No. _____ Size _____

15. Insulation _____

16. Paint _____

Internal Coating _____

17. Purchaser's Reference Documents:

SAMSSs _____

SASDs _____

Forms _____

Others _____

18. Remarks

Appendix IV
Completion of API SPEC 12P
Storage Tank Data Sheet

The Design Engineer shall complete Design Data Sheet 1 of API SPEC 12P as necessary for the particular tank application. The entries noted below shall be completed as follows for all applications.

1. An API SPEC 12P Monogram is required.
2. If a ladder is required, it must be caged when required by SAES-B-054.