Engineering Standard

SAES-D-001 30 March 2005

Design Criteria for Pressure Vessels

Saudi Aramco DeskTop Standards

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1 Scope

1.1 This standard covers the minimum mandatory requirements for the design of pressure vessels. The requirements are in addition to and supplement the requirements of the ASME Boiler and Pressure Vessel Codes.

1.2 This standard does not cover pressure vessels that undergo repairs or alterations and pressure vessels stamped "UM" per ASME SEC VIII D1.

1.3 This standard is intended to establish basic guidelines of mechanical design and to inform Design Engineers of preferred analytical design requirements.

1.4 The requirements in this standard shall be used by the Design Engineer for the completion of Saudi Aramco Vessel Data Sheet.

1.5 This standard shall not be attached to nor made a part of purchase orders.

1.6 Pressure vessels supplied as part of a vendor's off-the-shelf standard design package unit and intended for air or water services (e.g., air dryers, portable air compressors, filtering unit, etc.) with a design pressure no greater than 1.7 MPa (245 psi) and a design temperature no greater than 121ºC (250ºF) are exempt ed from meeting the requirements of this standard provided that:

a) The vessel is ASME Code stamped,

b) Full penetration welds joints are used, and

c) The vessel is protected against overpressure conditions.

1.7 This specification does not include in its scope equipment, which are made of pressure-containing components generally recognized as piping components (pipe, fittings, etc.). Equipment include strainers, pressure containers used for transferring liquids as an integral part of a piping system and devices that serve the purposes of mixing, separating, distributing, metering and controlling flow.

1.8 Where a licensor's specification requirement is more stringent than that of this specification, the licensor's specification requirement will govern.

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 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 of material and equipment, and the design and construction of pressure vessels 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 Sheet*
SAES-A-112	*Meteorological and Seismic Design Data*
SAES-A-301	*Materials Resistant to Sulfide Stress Corrosion Cracking*
SAES-B-006	*Fireproofing in Onshore Facilities*
SAES-C-001	*Process Design of Trays and Packing*
SAES-H-001	*Selection Requirements for Industrial Coatings*
SAES-H-101	*Approved Protective Coating Systems*
SAES-H-101V	*Approved Saudi Aramco Data Sheets - Paints and Coatings*
SAES-J-600	*Pressure Relief Devices*
SAES-L-109	*Selection of Flanges, Stud Bolts and Gaskets*
SAES-N-001	*Basic Criteria, Industrial Insulation*
SAES-N-100	*Refractory Systems*
SAES-X-500	*Cathodic Protection Vessels and Tank Internals*

Saudi Aramco Materials Systems Specifications

32-SAMSS-004	*Manufacture of Pressure Vessels*

32-SAMSS-020	*Manufacture of Trays and Packing*
32-SAMSS-031	*Manufacture of Clad Vessels and Heat Exchangers*

Saudi Aramco Forms and Data Sheets

2694-ENG	*Safety Instruction Sheet-Vessels*
9527-ENG	*Pressure Vessel Data Sheet (herein after referred to as data sheet)*

Saudi Aramco Standard Drawings

AB-036322	*Anchor Bolt Details*

3.2 Industry Codes and Standards

American Society of Civil Engineers

ASCE 7	*Minimum Design Loads for Buildings and Other Structures*

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

ASME B16.11	*Forged Steel Fittings, Socket-welded and Threaded*
ASME B16.20	*Metallic Gaskets for Pipe Flanges – Ring-Joint, Spiral-Wound and Jacketed*
ASME B16.21	*Nonmetallic Gaskets for Pipe Flanges*
ASME B16.47	*Large-Diameter Steel Flanges NPS 26 inch through NPS 60 inch*
ASME B16.5	*Pipe Flanges and Flanged Fittings*
ASME SEC II	*Materials*
ASME SEC VIII D1	*Rules for Construction of Pressure Vessels*
ASME SEC VIII D2	*Rules for Construction of Pressure Vessels, Alternative Design Rules*

Process Industry Practices

VEFV1100	*Vessels/S&T Heat Exchanger Standard Details*

Welding Research Council

WRC 107	*Welding Research Council Bulletin*
WRC 297	*Welding Research Council Bulletin*

4 Definitions

Amine Services: All amine solutions including MEA, DGA and ADIP.

Auto-Refrigeration Temperature: Auto-refrigeration temperature is the adiabatic vaporization temperature of the process fluid coincident with a pressure equal to 25% of the maximum operating pressure.

Caustic Services: All sodium hydroxide solutions at all temperatures and concentrations.

Cyclic Services: Services that require fatigue analysis per AD-160 of ASME SEC VIII D2. This applies to Division 1 and Division 2 of ASME SEC VIII.

Design Engineer: The Engineering Company responsible for specifying on the data sheet the mechanical design requirements for pressure vessels.

High - Alloy Steels: Steels with a total alloying content more than 5%.

Hydrogen Services: Process streams containing relatively pure hydrogen and component streams containing hydrogen with a partial pressure of 350 kPa abs (50 psia) and higher.

Lethal Services: Process streams containing a concentration of hydrogen sulfide in excess of 20% by volume shall be considered as lethal service. Other services as determined by the project design may also be designated as lethal services.

LODMAT: The lowest one day mean temperature at a site or location.

Low - Alloy Steels: Steels with a total alloying content of less than 5% but more than specified for carbon steels.

MDMT: Minimum design metal temperature, determined in accordance with this standard.

Nominal Thickness: The value of the design thickness required to withstand all primary loads, and includes allowance for corrosion.

P&ID: Piping & Instrument Diagram.

PFD: Process Flow Diagram.

Pressure Vessel and Vessel: As defined in the ASME Boiler & Pressure Vessel Codes.

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

Shock Chilling Effect: The rapid decrease in temperature of a vessel component caused by a sudden flow of process stream colder than -20°C and at a temperature lower than the initial temperature of the component by 40°C, regardless of pressure.

Thick Wall Vessel: A vessel or part of a vessel with nominal thickness greater than 50 mm.

Unfired Steam Drums: As defined in ASME SEC VIII D1.

Utility Services: Water, air and nitrogen services.

Vessel Manufacturer: The company responsible for the manufacture of pressure vessels.

Wet Sour Service: Following process streams containing water and hydrogen sulfide:

i) Sour water service with a hydrogen sulfide (H_2S) concentration above 2 mg/L (2 ppm) and a total pressure of 400 Kpa absolute (65 psia) or greater.

ii) Hydrocarbon services meeting the definition of sour environments in SAES-A-301, where the H_2S concentration of 2 mg/L (2 ppm) or more in the water phase is equivalent to H_2S partial pressure of 0.05 psia. Sour crude systems upstream of a stabilization facility and sour gas upstream of a sweetening or dehydration plant are examples of such environments.

iii) Hydrocarbon systems exposed to an environment with a H_2S concentration above 50 mg/L (50 ppm) in the water phase, regardless of H_2S partial pressure.

5 Responsibilities

5.1 The Design Engineer is responsible for specifying the mechanical design requirements and completing the data sheet in accordance with this standard.

5.2 The Vessel Manufacturer is responsible for the manufacture of pressure vessels, which includes the complete mechanical design, Code and structural calculations, supply of all materials, fabrication, nondestructive examination, inspection, testing, surface preparation, and preparation for shipment, in accordance with the completed data sheet and the requirements of 32-SAMSS-004 and 32-SAMSS-031, as applicable.

6 Basis for Mechanical Design

6.1 General

6.1.1 All pressure vessels, including unfired steam drums, shall be mechanically designed in accordance with ASME SEC VIII D1 or

ASME SEC VIII D2 (herein referred to as the Codes), and the requirements of 32-SAMSS-004 and, as applicable, 32-SAMSS-031.

6.1.2 The applicable Division and edition of the Codes to be used for the design of pressure vessels shall be specified on the data sheet.

6.1.3 ASME SEC VIII D2 shall be specified when economically justified. The following guidelines shall be used to determine when D2 should be considered:

a) When the nominal thickness of the vessel shell or heads exceeds 50 mm, irrespective of design pressure, materials, or service.

b) When the erected weight of the vessel, (excluding removable internal and external attachments) exceeds 90 Tonnes (100 Tons)

c) For vessels with design pressures 6.9 MPa (1000 psi) and larger, irrespective of service and materials of construction

6.1.4 It is the responsibility of the Design Engineer, as defined in this standard, to prepare a detailed User Specification for ASME SEC VIII D2 pressure vessels in accordance with paragraph AG-301 of Division 2.

6.1.5 The application of ASME Code Cases to the design of pressure vessels requires the prior approval of the Saudi Aramco Engineer.

6.1.6 Trays and packing shall be designed in accordance with SAES-C-001.

6.2 Design Pressure

6.2.1 Pressure vessels shall be designed to withstand the maximum internal and/or external pressure conditions which can occur during normal operation, including startup, shutdown or any unusual operation as shown on the PFD.

Commentary Note:

*Design pressure is the maximum difference in pressure between the inside and the outside of a vessel, or between the chambers of a combination unit. The term **internal design pressure** is used when the internal pressure is greater than the external pressure. However, the term **external design pressure** is used when the internal pressure is less than the external pressure.*

6.2.2 The values of normal operating pressure, maximum operating pressure, and design pressure acting at the top of a vessel shall be specified on the data sheet.

6.2.3 The internal design pressure shall not be less than the larger of the maximum operating pressure plus 100 KPa (15 psi) or 110% of the maximum operating pressure as shown on the PFD.

6.2.4 The design pressure for vessels with maximum operating pressures of 6.9 MPa (1000 psi) and above shall be a minimum of 105% of the maximum operating pressure as shown on the PFD.

6.2.5 Where there are differences in design pressures in different sections of a vessel, the extremities of these sections shall be specified on the data sheet.

6.2.6 For multi-compartment vessels, the differential design pressures between compartments shall be specified on the data sheet. In all cases, the design differential pressure shall be at least 1.1 times the maximum operating differential that can occur. All pressure differentials shall be considered.

6.2.7 Vessels in vacuum service shall be designed for a maximum external pressure of 100 kPa (15 psi) or 125% of the maximum operating external pressure, whichever is larger.

6.2.8 Vessels that are subject to steam-out conditions shall be designed for an external pressure of 50 KPa (7.5 psi) at 149°C (300°F).

6.2.9 All vessels in steam services shall be designed for an external pressure of 100 KPa (15 psi) at design temperature.

6.2.10 For vessels that contain packing, the following data shall be specified on the data sheet for the design of packing bed supports:

a) The differential design pressure and temperature at the end-of-process-run (fouled) condition.

b) The differential regeneration pressure and temperature.

c) The directions of the differential pressure corresponding to items (a) and (b).

6.3 Design Temperature

6.3.1 The design metal temperature shall not be less than the maximum operating temperature as shown on the PFD plus 28°C (50°F).

6.3.2 Where there are differences in the maximum operating temperature for the different operating temperatures of a vessel, the extremities of these sections shall be specified on the data sheet.

6.3.3 The design temperature for vessels which are internally refractory lined shall be calculated using the insulating properties of the lining material. Refer to SAES-N-100, Refractory Systems for the coefficients of thermal conductivity to be specified.

6.4 Minimum Design Metal Temperature

The MDMT shall be specified on the data sheet and shall be equal to the lower of the following conditions:

a) The LODMAT at the site location, unless a higher start-up temperature is specified and approved by operations, and a suitable warm-up start-up procedure has been developed.

b) The temperature of a process stream causing shock chilling condition as defined in section 4 of this standard.

c) Auto-refrigeration condition as defined in section 4 of this standard.

d) The minimum operating temperature at an operating pressure greater than 25% of the design pressure.

6.5 Service and Description

a) The service of a vessel (e.g., lethal, hydrocarbon, hydrogen, caustic, amine, wet sour, utility and cyclic) as defined in section 4 of this standard shall be specified on the data sheet.

b) The process description of the vessel (e.g., fractionator, regenerator, separator, receiver, KO drum, deaerator, etc.) shall be specified on the data sheet.

6.6 Joint Efficiency

A joint efficiency of 85% or higher shall be specified for the design of all pressure containing components of ASME SEC VIII D1 pressure vessels.

6.7 Corrosion Allowance

6.7.1 Corrosion allowance shall be based on achieving a minimum service life of twenty years.

6.7.2 The maximum amount of corrosion allowance shall be 6 mm. Should a higher corrosion allowance be required in order to obtain a twenty year service life, the vessel shall be integrally clad or weld overlayed with a corrosion resistant metallic lining or as an alternative solid corrosion resistant material shall be specified for the vessel. Selection of any of the alternatives shall be based on cost effectiveness and a proven history of satisfactory service in similar service environments.

6.7.3 Minimum corrosion allowances shall be specified on the data sheet as follows:

a) For all carbon and low-alloy steels, in all services, except wet sour services, the minimum corrosion allowance shall be specified as 1.5 mm.

b) For all carbon and low-chrome alloy steels in wet sour services the minimum corrosion allowance shall be specified as 3 mm.

c) For all integrally clad vessels, in all services, the minimum corrosion allowance shall be the cladding thickness of not less than 2.5 mm.

d) For all weld overlayed vessels, in all services, the minimum corrosion allowance shall be the weld overlay thickness of the specified chemical composition of not less than 2.5 mm.

6.7.4 No reductions to corrosion allowances specified in paragraph 6.7.3 shall be given for vessels which are internally coated with nonmetallic coatings.

6.7.5 Corrosion allowances for tray assemblies and tray support rings shall be specified in accordance with the requirements of 32-SAMSS-020.

6.8 Heads

6.8.1 The types of heads shall be specified on the data sheet.

6.8.2 The type of heads for vessels shall be specified as ASME 2:1-ellipsoidal or ASME hemispherical. ASME flanged and dished heads (torispherical) may only be used for utility services up to a design pressure of 690 KPa (100 psi).

6.8.3 For thick wall vessels, heads shall be specified as hemispherical unless 2:1 ellipsoidal heads are deemed economical. Torispherical heads shall not be used.

6.9 Loads

6.9.1 Wind and Earthquake Loads

a) Wind and earthquake loads shall be determined by the Vessel Manufacturer in accordance with the procedures detailed in ASCE 7.

b) The Design Engineer shall determine the basic wind speed corresponding to the Saudi Aramco site in accordance with

SAES-A-112. The basic wind speed shall be specified on the vessel data sheet.

c) The Design Engineer shall determine the earthquake zone, soil coefficient and effective peak acceleration ratio (Av) corresponding to the Saudi Aramco site in accordance with SAES-A-112. The earthquake zone and site soil coefficient shall be specified on the vessel data sheet.

6.9.2 Weight of Liquid Contents

The Design Engineer shall specify on the vessel data sheet the maximum operating liquid level and density of liquid as well as full hydrostatic test load for the vessel in the erected position.

6.9.3 Piping and Equipment Loads

a) Nozzles shall be designed for external piping loads, such as may be produced from thermal expansion/contraction and weight.

b) Where such conditions exist, the Design Engineer shall specify these loads on the data sheet.

c) For vessels supporting equipment (e.g., stab-in type heat exchanger, reboilers, etc.), the equipment loads imposed on the vessel are to be determined by the Design Engineer and specified on the data sheet.

6.9.4 Refractory Linings

a) For vessels which are refractory lined, the extent and design density of the refractory lining shall be specified on the data sheet.

b) The value of the design density of the refractory shall be determined in accordance with SAES-N-100.

6.10 Stress Analysis

6.10.1 Where applicable, the requirements for thermal stress and fatigue stress analyses are to be specified by the Design Engineer in accordance with this standard. When a thermal or fatigue analysis is required per this standard for a Division 1 vessel, the analysis methods and stress combination limits presented in Division 2, Appendix 4, may be used. However, the basic design stress intensity value, S_m, shall be taken from the Division 1 tables of ASME SEC II for the corresponding material and temperature.

6.10.2 The Design Engineer is responsible for specifying the heat transfer coefficients to be used for all thermal stress analysis.

6.10.3 Thermal Analysis

a) A thermal stress analysis is required for ASME SEC VIII D1 vessels if a thermal gradient along the circumferential or longitudinal axes, under steady state operating conditions, exceeds 65°C (150°F) in a distance measured as the square root of R times T, where:

- R is the radius of the vessel component under consideration and,
- T is the thickness of the component under consideration
- R and T are measured in the same units.

b) Thermal gradients may be reduced to within allowable limits with the provision of:

- Thermal sleeves in pressure-retaining components
- Hot-box design at the skirt-to-vessel junction in skirt-supported vessels with design temperatures greater than 260°C (500°F).

6.10.4 Vessels Designed in accordance with Division 2

a) The scope of the required stress analysis shall be specified by the Design Engineer in accordance with the rules of Division 2.

b) As a minimum, the scope of the stress analysis (in the steady state condition) shall be as follows:

- Head to shell weld
- Bottom head to skirt weld
- Nozzle to shell welds including external piping loads
- Tray supports to shell welds

6.10.5 Fatigue Analysis

a) A fatigue analysis shall be based on the calculated number of cycles for a minimum 20 year life cycle, as determined in accordance with the rules of Division 2, paragraph AD-160.

b) The number of cycles shall include the number of start-ups, shut-downs, emergency shut-downs, and upset conditions.

6.10.6 Local Stress Analysis

Stress analysis due to piping, equipment, lifting, supports and other external loads shall be completed in accordance with the procedures as detailed in WRC 107, WRC 297 or a finite element analysis.

7 Nozzles, Manways and Gaskets

7.1 General

7.1.1 The quantity, types, sizes, elevations, orientations and pressure classes of all nozzles and manways shall be specified on the data sheet.

7.1.2 The Design Engineer is responsible for ensuring that the facings, bolt centers, number of bolts and size of bolts of vessel nozzles match the mating piping flanges.

7.1.3 Design of bolted connections with stud bolts of diameter 1-½ inch and above shall be such as to provide clearance to permit use of a stud and bolt tensioner device.

7.1.4 The quantity and sizes of nozzles required for pressure relief valves shall be determined in accordance with SAES-J-600 and specified on the vessel data sheet.

7.1.5 The locations and sizes of nozzles shall be in accordance with the P&IDs and this standard.

7.1.6 Nozzles with NPS of 2-½, 3-½, and 5 shall not be used.

7.1.7 Nozzles less than NPS 2 are not permissible except for utility services.

7.1.8 Threaded or socket-welded connections are prohibited in the following services and conditions:

a) Lethal service.

b) Hydrogen service.

c) Caustic service.

d) Continuous or intermittent vibration.

e) Any service where crevice corrosion or severe erosion may occur.

f) Wet sour services.

7.1.9 Threaded or socket-welded connections with 3000# rating conforming to ASME B16.11 may be used for 1-½ inch NPS and smaller vents, drains and instrument connections in services other than those specified in paragraph 7.1.8 of this standard.

7.1.10 Vessels in services other than Utility services shall be provided with a minimum NPS 2 flanged steam-out connection.

7.1.11 Vessels shall be provided with vent and pressure relief connections unless such pressure relief devices are provided on the associated overhead piping.

7.1.12 All liquid level column instrument connections shall be located so as to avoid turbulent areas (e.g., turbulence from impact of inlet streams).

7.1.13 On vertical skirt-supported vessels in hydrocarbon, hydrogen, wet sour, caustic, amine and services, all nozzle flanges located on the bottom head shall be brought outside the skirt.

7.1.14 For vessels with mechanical mixers, the Design Engineer shall specify on the vessel data sheet: the torque, bending loads, and dimensional tolerances (axial and angular) specified by the mixer manufacturer.

7.1.15 Anti-swirl baffles (vortex breakers) shall be provided on liquid outlet nozzles upstream of a pump suction side.

7.2 Ratings (ASME Pressure Classes) and Facings

7.2.1 The ASME pressure classes shall be specified on the data sheet.

7.2.2 ASME Pressure Class 400 shall not be used.

7.2.3 Pressure ratings shall be in accordance with the following:

a) Pressure ratings of flanges 24-inch NPS and smaller shall be specified in accordance with ASME B16.5.

b) Pressure ratings of flanges larger than 24-inch NPS shall be specified in accordance with ASME B16.47, Series A.

7.2.4 The facings of flanges shall be specified as raised face or ring-type joint in accordance with SAES-L-109. Flat face flanges are permissible for only utility services.

7.2.5 Bolted joints specified with non-ASME flanges shall be designed to meet all anticipated loading conditions of the vessel.

7.3 Manways

7.3.1 The location, quantity, size of manways shall be specified in accordance with this standard and shall be specified to ensure that all interior areas are accessible. Requirements of internal ladder rungs shall be as specified in 32-SAMSS-004.

7.3.2 Manways in columns with trays shall be located as follows:

a) Manways are required at the top, at the bottom and at feed trays.

b) Intermediate manways shall have a maximum spacing of 10 trays.

7.3.3 The Design Engineer shall ensure that the size of manways are such that all removable internals, including tray sections, piping, filters, screens, etc., can pass through.

7.3.4 Vessels that contain catalyst or packing shall be provided with 24 inch minimum inside diameter manways. All other vessels shall have manways with 18 inch minimum inside diameters.

7.3.5 In cases where the diameter of the vessel is too small to accommodate an 18 inch minimum inside diameter manway, the largest size inspection openings shall be specified. The minimum sizes shall be in accordance with the design Codes.

7.3.6 Vessels with mixers shall be provided with at least one manway that does not require removal of the mixer.

7.3.7 All manways shall be circular. The manway covers shall be hinged or provided with handling davits as specified on the data sheet, according to PIP VEFV1100.

7.4 Gaskets

7.4.1 The type of gaskets shall be specified on the data sheet in accordance with SAES-L-109 requirements.

7.4.2 Spiral wound type gaskets shall be in accordance with ASME B16.20.

7.4.3 The design of spiral wound gaskets shall be as follows:

a) For all services and design temperatures, spiral wound gaskets shall be specified with solid outer centering rings.

b) For design temperatures above 450°C, spiral wound gaskets shall be specified with solid outer centering rings and inner confining rings.

c) For vessels in continuous vacuum or catalyst services, irrespective of design temperature or design pressure, spiral wound gaskets shall be specified with solid outer centering rings and inner confining rings.

7.4.4 The materials of gaskets shall be specified in accordance with 32-SAMSS-004.

7.4.5 Gaskets for utility services shall be specified as non-asbestos conforming to ASME B16.21, and must be chemically resistant and mechanically suitable for the service conditions.

7.5 Weld Attachment Details

7.5.1 All nozzles and manway necks shall be attached by welding completely through the total thickness of the vessel shell, head or nozzle wall, including any reinforcement. Backing rings used in attaching nozzles and manways to vessels shall be removed after welding.

7.5.2 Permissible types of nozzles larger than NPS 4 and manway necks weld-attachments are:

a) Division 1 vessels: Figure UW-16.1 (c), (d), (e), (f-1), (f-2), (f-3), (f-4) or (g).

b) Division 2 vessels: Figure AD-610.1: (c), (d), (e), (e-1), (g) or weld attachments in paragraph 7.5.4(b).

7.5.3 Permissible types of nozzle weld-attachments for vessels with NPS 4 and smaller connections are:

a) Division 1 vessels: Figure UW-16.1 (a), (a-1), (b) or weld attachments in paragraph 7.5.2(a).

b) Division 2 vessels: Figure AD-610.1 (a), (b), or weld attachments in paragraphs 7.5.2(b) and 7.5.4(b).

7.5.4 Permissible types of nozzle and manway weld-attachments that require 100% radiography according to Table 4 of this specification are:

a) Division 1 vessels: Figure UW-16.1: (f-1), (f-2), (f-3) or (f-4).

b) Division 2 vessels: Figure AD-613.1: (a), (b), (c), (c-1), (d) or (e).

7.5.5 NPS 4 and smaller connections attached to nozzles or manways shall be according to paragraph 7.5.3 of this specification.

8 Internals

8.1 The Design Engineer shall specify all design data required for the mechanical design of internals, including their locations and dimensions for piping distributors, anti-swirl baffles, screens, filters, packing supports, etc.

8.2 All design data required for the process design of trays and packing shall be specified in accordance with SAES-C-001.

9 Vessel Supports

9.1 General

9.1.1 Each vessel shall be designed as a self-supporting unit.

9.1.2 The type of support required shall be specified by the Design Engineer on the data sheet.

9.2 Supports for Vertical Vessels

9.2.1 Vertical vessels shall be supported by means of a skirt, legs or lugs.

9.2.2 The skirt height shall be specified on the data sheet.

9.2.3 The minimum number of legs or lugs shall be specified as four for vessels above 24 inches in diameter.

9.2.4 The locations and orientations of legs and lugs shall be specified on the data sheet.

9.3 Supports for Horizontal Vessels

9.3.1 Horizontal vessel shall be supported by two saddles with anchor bolts. The vessel shall be fixed at one saddle and free to move in the longitudinal direction, due to thermal and pressure differentials, at the other saddle.

9.3.2 The data sheet shall specify locations of the fixed and sliding saddles and dimension from vessel centerline to underside of saddle base plate.

10 Clips and Attachments

10.1 General

The Design Engineer shall specify the orientations, elevations and details of clips and attachments required for pipe supports, ladders, and platforms.

10.2 Insulation Support Rings

10.2.1 The thickness, extent, and method of support of external insulation shall be specified on the data sheet in accordance with SAES-N-001.

10.2.2 Supports required for the supporting of internal refractory materials shall be specified in accordance with SAES-N-100.

10.3 Equipment Davit

10.3.1 A davit for the lifting of equipment shall be specified for vessels containing removable internals such as trays, packing and relief valves.

10.3.2 The davit shall be designed and manufactured in accordance with VEFV1100.

10.4 Lifting Lugs

10.4.1 Lifting lugs or other attachments shall be specified for vessels to facilitate shipping and handling purposes.

10.4.2 The davit shall be designed and manufactured in accordance with VEFV1100.

11 Material Selection

11.1 General

11.1.1 The materials of construction for pressure and non-pressure components shall be based on the design temperature, minimum design metal temperature and service in accordance with 32-SAMSS-004, Table 1, Acceptable Materials for Carbon and Low-Alloy Steels.

11.1.2 The Design Engineer may propose alternative materials to those specified in 32-SAMSS-004, Table 1, at time of proposal, with prior approval of Saudi Aramco Engineer. Alternative materials must comply with all the requirements of the applicable Code and this specification.

11.1.3 Use of high alloy steels shall be based on the design temperature, minimum design metal temperature and intended service.

11.2 Impact Testing

The impact testing of vessel components shall be determined by the Vessel Manufacturer based on the material minimum design metal temperature

(MDMT), in accordance with the requirements specified in 32-SAMSS-004 and the applicable Code.

11.3 Postweld Heat Treatment (PWHT)

11.3.1 For carbon and low alloy steels, the following process services require PWHT. Other process conditions may also require PWHT, as determined during the project design or as specified by the Saudi Aramco Engineer.

a) All caustic soda (NaOH) solutions, at all temperatures.

b) All monoethanolamine (MEA) solutions, at all temperatures.

c) All diglycol amine (DGA) solutions above 140°C design temperature.

d) All rich amino di-isopropanol (ADIP) solutions above 90°C design temperature.

e) All lean ADIP solutions above 60°C design temperature.

f) Boiler deaerators above 80°C design temperature.

Commentary Note:

Vacuum deaerators operating at ambient temperature are exempt.

g) Vessels in hydrogen service at all temperatures manufactured from P-No.3, 4, and 5A/B/C base materials.

h) All methyldiethanolamine (MDEA) solutions, at all temperatures.

11.3.2 Code exemptions for PWHT are not permitted if PWHT is specified for process conditions in accordance with this standard.

12 Coatings and Painting

12.1 The selection of the type of coating and painting required shall be in accordance with SAES-H-001.

12.2 The Saudi Aramco Painting and Coating Specification (APCS) shall be selected from SAES-H-101 and specified on the data sheet together with the applicable Class 09 specification for the surface preparation and painting systems.

13 Fireproofing

The extent of fireproofing required on vessel skirts, lugs, legs, and saddles shall be determined in accordance with the requirements of SAES-B-006 and specified on the data sheet.

14 Cathodic Protection

Vessels shall be cathodically protected when required by SAES-X-500.

15 Drawings and Calculations

15.1 The data sheet, drawings and forms are to be completed by the Design Engineer to the extent as detailed in this standard.

15.2 The as built thicknesses of shells, heads, and supports shall be specified by the Design Engineer on the Safety Instruction Sheet (SIS) after the completion of fabrication.

15.3 All approved data sheets, drawings and forms are to be submitted to Engineering Drawings Services Division (EDSD) for inclusion into Corporate Drawings Management System.

15.4 The Design Engineer is responsible for the completion of the Safety Instruction Sheet (Form SA 2694-ENG) for the vessel in accordance with SAES-A-005 and the data on the Vessel Manufacturer's drawings.

Revision Summary

29 December 2004	Major revision.
30 March 2005	Editorial revision to replace NACE MR0175 with newly approved SAES-A-301.