# Engineering Standard

SAES-A-005 28 February 2005

Safety Instruction Sheet

Document Responsibility: Standards Coordinator

## Saudi Aramco DeskTop Standards

**Table of Contents**

## 1 Scope

This Standard outlines the procedure to be followed in the preparation of static equipment Safety Instruction Sheets (SIS) for new plants or additions to existing plants, and also for re-rating of existing equipment. Safety Instruction Sheets (SIS) for piping and pipelines is covered by SAES-L-125.

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

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

| | |
|---|---|
| *SAEP-302* | *Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement* |

Saudi Aramco Engineering Standards

| | |
|---|---|
| *SAES-A-004* | *Pressure Testing* |
| *SAES-D-001* | *Design Criteria of Pressure Vessels* |
| *SAES-D-100* | *Design Criteria of Atmospheric and Low-Pressure Tanks* |
| *SAES-D-108* | *Storage Tank Integrity* |
| *SAES-E-004* | *Design Criteria of Shell and Tube Heat Exchangers* |
| *SAES-E-006* | *Design Criteria of Double Pipe Heat Exchangers* |

| | |
|---|---|
| *SAES-E-007* | *Design Criteria of Air-Cooled Heat Exchangers* |
| *SAES-E-014* | *Design Criteria of Plate and Frame Heat Exchangers* |
| *SAES-E-015* | *Design Criteria of Electric Heat Exchangers* |
| *SAES-F-001* | *Design Criteria of Fired Heaters* |
| *SAES-J-600* | *Pressure Relief Devices* |

Saudi Aramco Materials System Specifications

| | |
|---|---|
| *32-SAMSS-004* | *Manufacture of Pressure Vessels* |
| *32-SAMSS-005* | *Manufacture of Atmospheric Tanks* |
| *32-SAMSS-006* | *Manufacture of Low Pressure Tanks* |
| *32-SAMSS-007* | *Manufacture of Shell and Tube Heat Exchangers* |

Saudi Aramco Forms and Data Sheets

| | |
|---|---|
| *2681* | *Skirt Design Sheet* |
| *2682* | *Vessel Design Sheet* |
| *2693-ENG* | *Tanks* |
| *2694-ENG & 2694-M-ENG* | *Vessels* |
| *2713-ENG & 2713-M-ENG* | *Shell and Tube Heat Exchangers* |
| *2714-ENG* | *Heat Exchanger Specification Sheet* |
| *2716-ENG & 2716-M-ENG* | *Air Cooled Heat Exchanger Specification Data Sheet* |
| *2731-ENG & 2731-M-ENG* | *Fired Heaters* |
| *6234* | *Electric Motor Data Sheet* |
| *6238-ENG & 6238-M-ENG* | *Air Cooled Heat Exchangers* |

3.2 Industry Codes and Standards

American Petroleum Institute

| | |
|---|---|
| *API STD 510* | *Pressure Vessel Inspection Code - Maintenance, Inspection, Rating, Repair, and Alteration* |

| | |
|---|---|
| *API STD 530* | *Calculation of Heater Tube Thickness in Petroleum Refineries* |
| *API STD 620* | *Design and Construction of Large, Welded, Low-Pressure Storage Tanks* |
| *API STD 650* | *Welded Steel Tanks for Oil Storage* |

American Society of Mechanical Engineers

| | |
|---|---|
| *ASME SEC I* | *Rules for Construction of Power Boilers* |
| *ASME SEC VIII* | *Rules for Construction of Pressure Vessels* |

## 4 Purpose

4.1 The purpose of safety instruction sheets is to ensure that operating, maintenance and inspection personnel will be provided with adequate information in a consistent format concerning safe equipment operating limits, protective devices and any special safety precautions.

4.2 SIS shall be prepared for all individual units of plant equipment which in view of size, pressure rating and application are within the scope of Saudi Aramco Engineering Standards and general industry codes referred to therein, including:

a. Pressure vessels within the scope of SAES-D-001.

b. Tanks within the scope of SAES-D-100.

c. Heat exchangers and coolers within the scope of SAES-E-004, SAES-E-006, SAES-E-007, SAES-E-014 and SAES-E-015.

d. Tubes, headers, drums in fired heaters and boilers within the scopes of SAES-F-001 and the ASME code.

## 5 Preparation

Safety Instruction Sheets are prepared for new plants or additions to existing plants as follows:

5.1 Process Equipment: A Safety Instruction Sheet is prepared for each piece of process equipment. Each SIS shall include, in addition to tabulated information, all significant and unusual hazards, recommendations, unusual inspections and tests relating to the piece of equipment. References to be used in preparing the SIS include design drawings, vendor's drawings, vendor's certificates, and inspection reports. The special Saudi Aramco Engineering Forms are used for this purpose.

On each form the required data shall be furnished, as specified, in accordance with the instructions given in the Attachments to this Standard.

The following Engineering Forms are available for preparation of SIS. Detailed guidelines listing the key numbers to complete these forms have been prepared and are shown as attachments.

a. 2694-ENG & 2694-M-ENG, Vessels, see Attachment D-1.

b. 2693-ENG, Tanks, see Attachment D-2.

c. 2713-ENG & 2713-M-ENG, Shell and Tube Heat Exchangers, see Attachment E-1.

d. 6238-ENG & 6238-M-ENG, Air cooled Heat Exchangers, see Attachment E-2.

e. 2731-ENG & 2731-M-ENG, Fired Heaters, see Attachment F.

5.2 Equipment not Covered by an Existing Form: In situations where a piece of equipment is not covered by a Saudi Aramco Form, one of the above forms shall be adapted to the purpose, or a special form to include the necessary information shall be prepared.

## 6 Approval

The Project Manager is responsible for the preparation, approval and issue of the Safety Instruction Sheets on new construction projects. When equipment or piping is installed or modified outside a new construction project scope, the Plant Manager is responsible for SIS preparation and approval.

Copies of the Safety Instruction Sheets and the applicable design data sheets may be submitted to the Manager, Consulting Services Department for review and concurrence by his designated representative(s) where CSD expertise is required. The Project Manager will issue revised sheets where necessary as a result of this review.

## 7 Control

Safety Instruction Sheets shall be assigned Saudi Aramco drawing numbers and shall become a part of the Project Photostat Book, Section A, and Project Inspection Record Books.

**Revision Summary**

28 February 2005 Major revision.

## Attachment D-1: Completion of Form 2694-ENG & 2694-M-ENG

| | |
|---|---|
| 1 | Give short but comprehensive description covering use or function of vessel using the title as shown on the drawings and project description wherever possible; e.g., stabilizer overhead knock-out drum, instrument air receiver, crude vacuum column, etc. |
| 2 | Plant number followed by the letter "D" or "C" and followed by sequence No.; e.g., 190-D-1, 2-C-204, etc. |
| 3 | Manufacturer's name and country where fabricated. |
| 4 | Position of vessel: horizontal, vertical, sloped (at angle of degrees with horizontal or with vertical, or millimeter per meter or inch per foot). |
| 5 | Manufacturer's serial number as stamped on nameplate. |
| 6 | Year built indicated on name plate. |
| 7 | Accounting plant No. (to be completed by user). |
| 8 | Specification 32-SAMSS-004 or other, as applicable. |
| 9 | Saudi Aramco Purchase Order number, including suffix letters such as DA, HA, TA, NA. |
| 10 | Major Saudi Aramco drawings and foreign print numbers. |
| 11 | Drawing number of design data sheet, Form 2682. |
| 12 | Drawing number of skirt design sheet, Form 2681, if any. |
| 13 | ASME-Code or other, whichever is applicable. Show Code Section, year of issue and addenda. |
| 14 | ASME or other material specification for Shell and Head. In case other than ASME specification is applicable also indicate the allowable working stress under 39, if different from the Code requirements for the ASME material. |
| 15 | List sections of the vessel that is different in diameter and/or material thickness. If vessel is of uniform diameter and wall thickness, use the word shell in this column. |
| 16 | The data shall be taken from the certified Vendor's drawings. |
| 17 | List heads; both top and bottom heads, top or bottom head as required. |

| | |
|---|---|
| 18 | Minimum thickness as indicated on the certified Vendor's drawing, as reported by the inspector, or taken from Vendor's certificates. |
| 19 | Form of head such as ellipsoidal with axis ratio; or dished, crown radius and knuckle radius as applicable. |
| 20, 21 | As indicated on certified Vendor's drawings and/or inspection report. |
| 22 | Yes or no, based on inspection report and Vendor's certificates (cross out the non-applicable item). |
| 23 | 100%, spot, or none, based on inspection report and Vendor's certificates (cross out the non-applicable item). |
| 24 | Joint efficiency in accordance with ASME SEC VIII. |
| 25, 26 | The Basis for Calculated Test Pressure to be indicated is the lowest value of the bases for calculated test pressures for all components of the vessel on the basis of the design temperature as indicated on the vessel design sheet (Form 2682) and the data shown under key number 14 through 24 inclusive, and 36 and 37. See ASME SEC VIII, paragraph UG-99(c) and UA-60(e).<br><br>For vessels already in service, refer to API STD 510 for methods of calculating $t_m$ and SAES-A-004 for determining the test pressure. |
| 27 | Component having the lowest Basis for Calculated Test Pressure is limiting. Special attention should be given to flanges of flanged openings for limitation of the calculated test pressure, because the pressure rating variation with temperature differs from the ASME Code. (Refer to ANSI B16.5). Include limitations of hydrostatic liquid level required by design of bottom heads or supports. |
| 28, 29 | List the shop hydrostatic test pressure and position as specified on the design sheet and/or the Saudi Aramco outline drawing, or inspection report and/or Vendor's test certificate. Normally, the shop tests new are specified to be in the horizontal position. Check this value which should be 1.5 times the basis for calculated test pressure multiplied by the lowest ratio (for all materials of which the vessel is constructed) of the allowable stress at the test temperature of the vessel to the allowable stress at the design temperature. |
| 30, 31 | List the field hydrostatic test pressure and position as specified on the design data sheet and/or the Saudi Aramco outline drawing. In case this information is not shown on these documents, the field hydrostatic test pressure is the same as the shop test pressure if the vessel is tested in the same position. If a vertical vessel was shop tested in a horizontal position, an adjustment should be made for the hydrostatic head at the bottom parts of |

| | |
|---|---|
| | the vessel assuming that the vessel will be completely filled with water during the field hydrostatic test with the vessel in the vertical and final position. During the hydrostatic test of high columns or drums, the material stress in the bottom parts of the vessel shall not exceed 90% of the yield stress for the specified material. |
| 32, 33, 34 & 35 | As applicable. |
| 36 | List the ASME Class and facing, e.g., Class 150 ASME RF. |
| 37 | State the size and type of manhole. This can be in accordance with the ASME Code using forged steel welding neck flange and blind flange, or in accordance with Saudi Aramco Standard Drawing, AB-036215 (see SAES-D-001). |
| 38 | State the insulation thickness and type as applicable. |
| 39 | As applicable. (See key number 14 above.) Include any special requirements for testing or operation such as guyed vessel, maximum liquid level because of design of supports. |
| 40, 41 | State the design pressure and temperature as indicated on the vessel design sheet or the design pressure and temperature established in accordance with SAES-D-004. |
| 42 | This should be determined for vessels operating under vacuum only and for vessels where a possibility exists that due to misoperation (including draining after hydrostatic test or after steaming for gas-freeing), vacuum may occur. Vessels to be taken in the corroded condition. Calculation method is indicated in ASME Code. |
| 43 | As applicable. Usually: "Operating Requirements" is listed here as specified in the process design. Refer to vessel design sheet Form 2682. |
| 44 | State location of safety valve; e.g., top head, fill line, etc. |
| 45 | State safety valve setting. This normally is equal to the design pressure adjusted for the operating hydrostatic head.<br><br>See vessel design sheet Form 2682. The safety valve setting shall not exceed the maximum allowable working pressure as defined in paragraph UG-98 of the ASME SEC VIII. |
| 46 | State the routine hydrostatic test pressure for periodic inspection. This pressure is 1.5 times the design pressure as stated under key number 40. |

47 List the various shell sections and heads as under key numbers 15 and 17 above.

48 Refer to the vessel design sheet (Form SA 2682) or compute the minimum required thicknesses per Code indicated under key number 13 based on the design pressure and temperature and other governing considerations. For NON-CODE vessels compute the minimum required wall thickness per ASME SEC VIII, adjusted for other loading, UG-22, and state the basis under key number 51.

49 State the corrosion allowance for the shell sections and heads.

50 As applicable: normally this will be "indicated design pressure and temperature". However, other conditions such as "code limit", "hydrostatic test pressure" or others like "windload", "as-built dimensions and data", may govern.

51 For non-code vessels state: "t(m) calculated per ASME SEC VIII, Edition....., addenda.....".

52 Any particulars that are of interest to Inspection and Maintenance.

53 District and Location of vessel. e.g., "Ras Tanura Refinery".

54 Title of plant or plant section of which the vessel is a part.

55 Follow usual procedure to obtain drawing number.

56 Engineering concurrence as indicated in Section 4 of this Standard plus the Project Manager or Plant Manager's approval, as required.

57 Complete this section showing date prepared, and name of originator.

58 Include BI and JO under which the equipment was installed.

59 Show Plant No.

60 Signature of Facility Engineering Division head.

REFERENCES:

ASME SEC VIII
SAES Section D
32-SAMSS-004

Saudi Aramco 2694-ENG (7/91)

| APP'D | CERT. | CHKD. | DESCRIPTION | JO/EWO | BY | DATE | NO. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REVISIONS

# SAUDI ARABIAN OIL COMPANY

## DATA AND OPERATING LIMITS SHEET - VESSELS

### EQUIPMENT DATA

Service (1) No. (2)
Manufacturer (3) Set (4)
Manufacturer's Serial No. (5) Year Built (6)
Equipment No. (7) Spec'n. No. (8) Order No. (9)
Assembly Drawings (10) Design Sheet No. (11)
Applicable Code and Edition (13) Skirt Design Sheet (12)

| SHELL | | | | HEADS | | | |
|---|---|---|---|---|---|---|---|
| Material (14) | | | | Material (14) | | | |
| Shell Section | I.D. | Nom. Thick. | Length | Head | I.D. | Min. Thick. | Form |
| | | | | | | | |
| (15) | | (16) | | (17) | | (18) | (19) |
| | | | | | | | |
| | | | | | | | |

| SEAMS | TYPE | RADIOGRAPHY | EFFICIENCY E |
|---|---|---|---|
| Shell | (20) | Spot / Full | 0.85 / 1.0 (24) |
| Head | (21) | Full (23) | 1.0 |
| Shell to Head | | Partial / Full | 1.0 |

Post Weld Heat Treatment: YES | NO (22)

Basis for calculated test pressure (25) psi. @ (26) °F
Limited by (27)
Tests New: Shop (28) psi (29) Position Field (30) psi At Top (31) Position
Trays: No., Mat'l. and Drawing No. (32)
Packing: Size, Height and Mat'l. (33)
Lining: Thick., Mat'l. and (34)
Method of Attachment (35)
Nozzle: Rating and Facing (36)
Manhole: Rating and Facing (37)
Insulation: Thick. and Type (38)
Special Design Considerations or (39)
Unusual Construction Features

DRAWN BY ..... DATE (57) CHKD BY .....
OPRG. DEPT. BY ..... DATE (56)
ENG. DEPT. BY ..... DATE (56)
APPD. FOR CONSTR. BY ..... DATE (56)
CERTIFIED BY ..... DATE (60)

### OPERATING LIMITS
(CONSULT DESIGNS ENGINEER BEFORE CHANGING THESE LIMITS)

Design Pressure at Top (40) psig (41) °F Safe for Full Vacuum: (42)
Based on (43)
Protected by Safety Valve on (44) S. V. Set at (45) psi
Test Pressure, at Top (46) psi

Minimum Thickness Based on indicated design pressure and temperature test pressure, wind load, or other governing consideration

| Shell Section | tm | c | Based on: |
|---|---|---|---|
| (47) | (48) | (49) | (50) |
| | | | |
| | | | |
| Heads: | | | |
| | | | |

(51)

### SAFETY PRECAUTIONS

Note below any special hazards, recommendations, inspections or tests that are important for the above equipment.
(52)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

SAFETY INSTRUCTIONS SHEET - VESSELS (53) (54) SAUDI ARABIA

| PLANT NO. | INDEX | DRAWING NO. | SHT. NO. | REV. NO. |
|---|---|---|---|---|
| (59) | A | E - (55) | | |
| JO/EWO - (58) | | | | |

Saudi Aramco 2694-M-ENG (3/91)

**SAUDI ARABIAN OIL COMPANY**

**DATA AND OPERATING LIMITS SHEET - VESSELS**

APP'D | CERT. | CHKD. | DESCRIPTION | JO/EWO | BY | DATE | NO. | REVISIONS

## EQUIPMENT DATA

Service (1) No. (2)
Manufacturer (3) Set (4)
Manufacturer's Serial No. (5) Year Built (6)
Equipment No. (7) Spec'n. No. (8) Order No. (9)
Assembly Drawings (10) Design Sheet No. (11)
Applicable Code and Edition (13) Skirt Design Sheet (12)

| SHELL | | | | HEADS | | | |
|---|---|---|---|---|---|---|---|
| Material (14) | | | | Material (14) | | | |
| Shell Section | I.D. | Nom. Thick. | Length | Head | I.D. | Min. Thick. | Form |
| | | | | | | | |
| (15) | | (16) | | (17) | | (18) | (19) |
| | | | | | | | |
| | | | | | | | |

| SEAMS | TYPE | RADIOGRAPHY | EFFICIENCY E |
|---|---|---|---|
| Shell | (20) | Spot / Full | 0.85 / 1.0 (24) |
| Head | (21) | Full (23) | 1.0 |
| Shell to Head | | Partial / Full | 1.0 |

Post Weld Heat Treatment: YES | NO (22)

Basis for calculated test pressure (25) kPa(ga) @ (26) °C
Limited by (27)
Tests New: Shop (28) kPa(ga) (29) Position Field (30) kPa(ga) At Top (31) Position
Trays: No., Mat'l. and Drawing No. (32)
Packing: Size, Height and Mat'l. (33)
Lining: Thick., Mat'l. and (34)
Method of Attachment (35)
Nozzle: Rating and Facing (36)
Manhole: Rating and Facing (37)
Insulation: Thick. and Type (38)
Special Design Considerations or (39)
Unusual Construction Features

## OPERATING LIMITS
(CONSULT DESIGNS ENGINEER BEFORE CHANGING THESE LIMITS)

Design Pressure at Top (40) kPa(ga) (41) °C Safe for Full Vacuum: (42)
Based on (43)
Protected by Safety Valve on (44) S. V. Set at (45) psi
Test Pressure, at Top (46) kPa(ga)

Minimum Thickness
Based on indicated design pressure and temperature test pressure, wind load, or other governing consideration

| Shell Section | tm | c | Based on: |
|---|---|---|---|
| (47) | (48) | (49) | (50) |
| | | | |
| | | | |
| Heads: | | | |
| | | | |

(51)

DRAWN BY ..... DATE (57) CHKD BY .....
OPRG. DEPT. BY ..... DATE (56)
ENG. DEPT. BY ..... DATE (56)
APPD. FOR CONSTR. BY ..... DATE (56)
CERTIFIED BY ..... DATE (60)

## SAFETY PRECAUTIONS

Note below any special hazards, recommendations, inspections or tests that are important for the above equipment.
(52)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

SAFETY INSTRUCTIONS SHEET - VESSELS (53) (54) SAUDI ARABIA

| PLANT NO. | INDEX | DRAWING NO. | SHT. NO. | REV. NO. |
|---|---|---|---|---|
| (59) | A | E- (55) | | |
| JO/EWO - (58) | | | | |

## Attachment D-2: Completion of Form 2693-ENG

| | |
|---|---|
| 1 | This is normally the product stored in the tank. Add the relative density of the liquid stored. Example: Rel. Density or Relative Density 0.86. If there is anything unusual about the condition of storage this should also be stated. For instance - LPG at 7 kPa (1 psi) and -34°C (-30°F). |
| 2 | Indicate specific gravity of product stored. |
| 3 | The tank operating number. This is the site number at the plant location, such as T-266, T-1579, etc. |
| 4 | Indicate construction contractor (erector). |
| 5 | In this space show the district and the plant, for example: Abqaiq Bulk Plant, Dhahran Stabilizer, Ras Tanura Terminal. |
| 6 | Indicate date erection was completed, not date of requisition |
| 7 | Indicate designer/fabricator not local vendor. |
| 8 | The code which covers the tank in question with the year of issue should be entered here. For example API STD 620, 1980 or API STD 650, 1986. |
| 9 | Enter design pressure, i.e., 7 kPa (1 psi). |
| 10 | Enter design temperature, i.e., -34°C (-30°F). |
| 11 | Enter flash point of the product stored in the tank. |
| 12 | Diameter in meters (feet and inches). |
| 13 | Height in meters (feet and inches). |
| 14 | This is the Joint Efficiency specified by the code and code appendix, where relevant, that is used (key number 8). |
| 15 | Indicate the maximum operating liquid height for which the tank was designed. |
| 16 | This is the nominal capacity not the exact capacity, 1600 $m^3$ (10 000 bbl), rather than 1612 $m^3$ (10 137 bbl). |
| 17 | Enter number of windgirder(s) installed. If no windgirder is installed enter "none". Indicate windgirder location. |

| | |
|---|---|
| 18 | State nozzle flange ratings according to ANSI class and the face type. For example, class 150 RF. |
| 19 | Applicable Foreign Print numbers (assembly drawings). |
| 20 | Applicable Saudi Aramco or Foreign Print drawings for appurtenances. |
| 21 | The Purchase Order number should be entered here, including Purchase Office suffix such as HA, DA, TA. |
| 22 | This should be welded, bolted, riveted. |
| 23 | The nominal plate thickness shown on the material test reports or inspection reports should be entered here. |
| 24 | The design thickness, inclusive of corrosion allowance ($C_a$). |
| 25 | Retirement thickness is the minimum required shell plate thickness for each course, exclusive of corrosion allowance ($C_a$). For Buttwelded Tanks, conforming to API STD 650, the ($t_m$'s) shall be determined in accordance with SAES-D-108. For Low Pressure Storage Tanks designed to API STD 620, the ($t_m$'s) shall be determined in accordance with API STD 620. |
| 26 | This is not the specified corrosion allowance but the difference between key numbers 23 and 25. |
| 27 | State height of each course. |
| 28 | The material specification for each course is listed here. |
| 29, 30 | For tanks designed and constructed to either API STD 650 Basic Procedure or API STD 650 Appendices the minimum yield and tensile strength stated shall be that given on certified mill physical test reports or when not available, the specified minimum yield and tensile strength given by the applicable standard under which the steel was produced.<br><br>For API STD 620 material and construction methods the minimum yield point (psi, or this value converted to MPa) shown on Table 3.1 of API STD 620 shall be used. |
| 31 | This should be Floating, Cone, Self Supporting, Dome. |
| 32 | Roof Plate Nominal Thickness from material test reports, inspection reports or Vendor's drawings. |
| 33 | The specifications for the roof components are listed here. |

| | |
|---|---|
| 34 | State here - Earth Fill, Concrete Ring. |
| 35 | Bottom annular and plate thickness from material test reports, inspection reports or Vendor's drawings. |
| 36 | The specifications for the annular and bottom plates are listed here. Revise when new bottom is installed. |
| 37,38,39 40,41,42 | Safety Devices installed should be identified. |
| 43, 44, 45 & 46 | The size and number of applicable drains shall be listed. |
| 47 | Specify date that tank settlement readings were taken. |
| 48,49 | Indicate the before and after hydrotest settlement readings. An adequate number of readings shall be taken. Settlement readings are normally taken on the top side of the annular plates. |
| 50 | Any particulars that are of interest to Inspection and Maintenance. Also, specify the method of ($t_m$) calculation. Indicate Standards used. |
| 51 | District and area. Example: Ras Tanura Terminal. |
| 52 | Show Plant No. |
| 53 | Indicate index "A". |
| 54 | Follow usual procedure to obtain drawing number. |
| 55 | Include BI and JO under which the equipment was installed. |
| 56 | Complete this section showing date prepared and name of originator. |
| 57 | Engineering concurrence as indicated in Section 4 plus Project Manager or Plant Manager's approval, as required. |
| 58 | Signature of Facility Engineering Division head. |

REFERENCES:

API STD 650
API STD 620
SAES-D-100, SAES-D-108
32-SAMSS-005
32-SAMSS-006

Saudi Aramco 2693-ENG (5/96)

# SAUDI ARABIAN OIL COMPANY

## DATA AND OPERATING LIMITS SHEET - TANKS

### EQUIPMENT DATA

Service ① Specific Gravity ② Tank No. ③
Erector ④ Location ⑤ Year Built ⑥
Designer ⑦ Applicable Code ⑧
Design Pressure ⑨ kPa (psi) Design Metal Temperature ⑩ °C(°F) Flash point ⑪ °C(°F)
Nominal Diameter ⑫ m (ft) Height ⑬ m (ft) Weld Joint Eff. ⑭
Max. Operating Liquid Level ⑮ Nom. Capacity ⑯
No. of Windgirder ⑰ Location/Dist. from Top ⑰
Nozzle Ratings ⑱
Assembly Dwgs. ⑲ Appurtenance Dwgs. ⑳ Order No. ㉑

### OPERATING LIMITS

(CHANGES TO OPERATING LIMITS REQUIRE OPERATIONS ENGINEERING APPROVAL)

| Shell ㉒ | | | | | | | | | Roof | Bottom | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Course No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Type | Foundation | |
| Nom. Thick. mm (ins) ㉓ | | | | | | | | | | ㉛ | ㉞ | |
| Des. Thick. mm (ins) ㉔ | | | | | | | | | | Thick mm (ins) | Nom. Thick mm (ins) | |
| Ret. Thick. mm (ins) ㉕ | | | | | | | | | | ㉜ | Anul. | Bot. |
| Corr. Allow. mm (ins) ㉖ | | | | | | | | | | | ㉟ | ㉟ |
| Course HT. m (ft) ㉗ | | | | | | | | | | | | |
| Material ㉘ | | | | | | | | | | | | |
| Min. Yield ㉙ | | | | | | | | | | Material | Material | |
| Min. Ten. ㉚ | | | | | | | | | | ㉝ | ㊱ | |

| Safety Devices | Size | No. | Type | Fig. No. |
|---|---|---|---|---|
| Rim Vents ㊲ | | | | |
| Breather Valves ㊳ | | | | |
| Vacuum Vents ㊴ | | | | |
| Free/Open Vents ㊵ | | | | |
| Emergency Vents ㊶ | | | | |
| Auto Bleeder Vents ㊷ | | | | |

| Drains | Size | Quant. |
|---|---|---|
| Emergency ㊸ | | |
| Open Drain ㊹ | | |
| Artic. Pipe ㊻ | | |

Tank settlement - Shell mm (ins) ㊼

| Sett. Readings | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Before Hydro. ㊽ | | | | | | | | | | | | | |
| After Hydro. ㊾ | | | | | | | | | | | | | |

### SAFETY PRECAUTIONS

Note below any special hazards, recommendations, inspections, or tests that are important for this equipment:
㊿

DESCRIPTION | NO. | DATE | BY | JO/EWO | APPD. | CERT. | CHKD.

REVISIONS

DRAWN BY ..... DATE ..... ㊻
CHECKED BY .....

OPRG. DEPT. BY ..... DATE ..... ㊼
ENG. DEPT. BY ..... DATE ..... ㊼
APPD. FOR CONSTR. BY ..... DATE ..... ㊼
CERTIFIED BY ..... DATE ..... ㊽

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDEING MATERIALS UNTIL CERTIFIED AND DATED

| SAFETY INSTRUCTION SHEET - TANKS | PLANT NO. | INDEX | DRAWING NO. | SHT. NO. | REV. NO. |
|---|---|---|---|---|---|
| ㊶ | ㊷ | ㊸ A | E- ㊹ | | |
| SAUDI ARABIA | JO/EWO - ㊺ | | | | |

## Attachment E-1: Completion of Form 2713-ENG & 2713-M-ENG

| | |
|---|---|
| 1 | Give short but comprehensive description covering use or function of exchanger; e.g., butane cooler, deethanizer condenser. |
| 2a | Plant No. followed by sequence No.; e.g., 190-E-1, 2-E-204 (same as key number 80). |
| 2b | Accounting plant No. (to be completed by the user). |
| 3 | Manufacturer's name and country where fabricated. |
| 4 | From Manufacturer's identification. (If Saudi Aramco Standard Heat Exchanger: Diameter of shell in mm (in) - length of tubes in mm (in) - (surface in $m^2$). |
| 5 | As applicable (e.g., shell and tube, or double pipe, for Saudi Aramco Standard Heat exchangers fill in "Saudi Aramco Standard"). |
| 6 | Serial number as stamped on nameplate. |
| 7 | Saudi Aramco purchase order number, including suffix letters such as DA, HA, TA, NA. |
| 8 | Year built as indicated on nameplate. |
| 9 | ASME or TEMA Code or other whichever is applicable. Show Code section and year of issue. |
| 10, 11 | From Manufacturer's data (For Saudi Aramco Standard Heat Exchangers see SAES-E-005). |
| 12 | List major Saudi Aramco drawings and foreign print numbers. |
| 13 | Shell side product stream indicated on heat exchanger specification sheet, Form 2714-ENG. |
| 14 | Diameter inside or outside (ID or OD). |
| 15 | Nominal shell plate thickness (new). |
| 16 | Length of shell between flange faces. |
| 17 | Specification of material used. |
| 18 | Double or single buttweld (DBW or SBW). For shells made of seamless pipe - SEAMLESS. |
| 19, 20 | Yes or no. |
| 21 | Joint efficiency, in accordance with ASME SEC VIII. |

| | |
|---|---|
| 22 | Basis for Calculated Test Pressure to be indicated is the lowest value of all bases for calculated test pressures determined for the various exchanger components subjected to shell side pressure and design temperature. See ASME Code, paragraph UG-99(c), Appendix 3. |
| 23 | Design temperature on the shell side. |
| 24 | Hydrostatic test pressure applied by manufacturer as stated in Design Data Sheet or Inspection Report. |
| 25 | The exchanger component that limits the Basis for Calculated Test Pressure on the shell side. |
| 26 | For dished heads indicate crown radius and knuckle radius; for ellipsoidal heads the ratio of inside major axis to inside minor axis. |
| 27, 28 | ASTM Material Specification or equivalent and wall thickness. |
| 29 | Tube side product as indicated on heat exchanger specification sheet, Form 2714-ENG. |
| 30,31,32 | Outside diameter, wall thickness, and length of tubes. |
| 33 | Layout may be triangular or rectangular, spacing is center-to-center distance between tubes. |
| 34 | Basis for Calculated Test Pressure to be indicated is the lowest value of all bases for calculated test pressures determined for the various exchanger components subjected to the tube side pressure and temperature. See ASME SEC VIII, paragraph UG-99(c), Appendix 3. |
| 35 | Design temperature on the tube side. |
| 36 | Hydrostatic test pressure applied by Manufacturer as stated in Inspection Report. |
| 37 | The exchanger component that limits the Basis for Calculated Test Pressure on the tube side. |
| 38,39,40 | ASTM Material Specifications or equivalent and applicable wall thickness from Manufacter's drawings. |
| 41 | To be completed by the user. For single bundle per exchanger, only left side of this section key numbers 41 thru 54 is to be completed. |
| 42 | Tube material specification. |

| | |
|---|---|
| 43, 46 | Number of tubes, see Form 2714-ENG, Heat Exchanger Specification Sheet and or Manufacturer's drawings. |
| 44, 47 | External area of all tubes, see Form 2714-ENG, Heat Exchanger Specification Sheet. |
| 45, 48 | Number of tube passes, see Form 2714-ENG, Heat Exchanger Specific action Sheet. |
| 49,51 | Tube sheet material specification. |
| 50,52 | Nominal thickness of tube sheet from Manufacturer's drawings. |
| 53 | State components which are lined and the material of the lining. |
| 54, 55, 64, & 65 | For new equipment this information is shown on the Heat Exchanger Specification Sheet (Form 2714-ENG) for the subject exchanger. When the service conditions of existing equipment are changed the design pressure shall be the maximum inlet pressure plus 100 kPa (15 psi) or 10% whichever is larger and the design temperature shall be 30°C (50°F) or 10% higher than the maximum operating metal temperature whichever is larger. |
| 56, 66 | Usually "operating conditions". |
| 57, 67 | Location of relief valve. |
| 58, 68 | Relief valve setting. (Refer to SAES-J-600). |
| 59, 69 | 1.5 times the design pressure. |
| 60, 70 | Design pressure or relief valve setting, if less than design pressure. |
| 61, 71 | Design temperature. |
| 62, 72 | The minimum thickness ($t_m$'s) calculated in accordance with ASME Unfired Pressure Vessel Code and TEMA specifications. ($t_m$'s) for tube sheets may be calculated in accordance with the ASME Unfired Pressure Vessel Code and TEMA specifications but it is usually satisfactory to deduct shell side and tube side corrosion allowances shown on Form 2714-ENG, from the tube sheet thickness t, where t is the tube sheet thickness in the partition plate groove. For tube sheets clad with non-corrosive material such as monel, deduct shell side corrosion allowance on Form 2714-ENG, from the tube sheet thickness t, where t is the overall tube sheet thickness minus the cladding thickness. |
| 63, 73 | Corrosion allowance = actual thickness minus minimum thickness ($t_m$). If the second method under key numbers 64 and 74 is followed to determine ($t_m$) the tube sheet corrosion allowance = t minus ($t_m$), where "t" is the tube sheet thickness in the partition plate groove. This excludes the partition |

plate groove depth from the corrosion allowance and this should be stated under key number 78.

74 Drawing number of Design Data Sheet, Form 2714-ENG.

75 Drawing number of Bolt and Gasket List.

76 Any particulars that are of interest to Inspection and Maintenance, e.g.,

a. Whether or not the gasket groove depth in the channel cover and partition plate groove depth of tube sheets have been included in the corrosion allowance.

b. Number of spare bundles available.

c. Interchangeability of tube bundle with that of any other exchanger.

d. Any special hazards connected with the equipment.

77 Engineering plant number followed by "-E-" and followed by sequence number; e.g., 16-E-112, 332-E-401.

78 Show area and location.

79 Show plant number

80 Show Index "A".

81 Follow usual procedure to obtain drawing number.

82 Engineering concurrence as indicated in Section 4 plus Project Manager or Plant Manager's, approval as required.

83 Complete this section showing date prepared and name of originator.

84 Signature of Facility Engineering Division head.

85 Include BI and JO under which the equipment was installed.

REFERENCES:

ASME SEC VIII
SAES-A-005, Attachment D-1
SAES-D-001
SAES, Section E
32-SAMSS-007

Saudi Aramco 2713-ENG (2/90)

## SAUDI ARABIAN OIL COMPANY

### DATA AND OPERATING LIMITS – HEAT EXCHANGERS

#### EQUIPMENT DATA

SERVICE: (1) | ITEM NO.: (2a)
MFR.: (3) | SIZE: (4) | PLANT EQUIPM. NO.: (2b)
MFR. SERIAL NO.: (6) | ORDER NO.: (7) | TYPE: (5)
APPLICABLE CODE & EDITION: (9) | YEAR BUILT: (8)
EQUIPMENT DRAWINGS: (12) | WEIGHT COMPLETE: (10) | WEIGHT BUNDLE: (11)

#### SHELL SIDE

FLUID: (13) | DIA.: (14) IN. D. | IN. THICK. (15) | LG.: (16) | MAT'L.: (17)
TYPE LONG SEAM: (18) | SR.: (19) | X-RAY: (20) | E (21) % | BASIS FOR CALCULATED TEST PRESSURE (22) PSIG. | (23) °F
TEST APPLIED NEW: (24) PSIG. | LIMITED BY: (25)
COVER | FORM: (26) | MAT'L: (27) IN. THICK | RING MAT'L: (28)

#### TUBE SIDE

FLUID: (29) | TUBES (30) IN. O.D. | (31) BWG | (32) IN. LG.
LAYOUT & SPACING: (33) | BASIS FOR CALCULATED TEST PRESSURE (34) PSIG. | (35) °F
TEST APPLIED NEW: (36) PSIG. | LIMITED BY: (37)
CHANNEL MAT'L: (38) IN. THICK | COVER MAT'L: (39) IN. THICK | FLT. HD. MAT'L: (40) IN. THICK

#### TUBE BUNDLE DETAILS

BUNDLE NO.: (41) | TUBE MAT'L: (42)
NO. PER UNIT: (43) | EXT. AREA: (44) $FT^2$ | NO. PASS: (45) | NO. PER UNIT: (46) | EXT. AREA: (47) $FT^2$ | NO. PASS: (48)
TUBE SHEET MAT'L: (49) | IN. THICK (50) | TUBE SHEET MAT'L: (51) | IN. THICK (52)
LININGS: (53)

#### OPERATING LIMITS

(OPERATING LIMIT REQUIRE OPERATIONS ENGINEERING APPROVAL)

| SHELL | | TUBES | |
|---|---|---|---|
| DESIGN PRESS.: (54) PSI (55) °F | | DESIGN PRESS.: (64) PSI (65) °F | |
| BASED ON: (56) | | BASED ON: (66) | |
| PROTECTED BY RELIEF VALVE ON: (57) | | PROTECTED BY RELIEF VALVE ON: (67) | |
| RV. SET AT: (58) PSI / ROUTINE TEST PRESSURE: (59) PSI | | RV. SET AT: (68) PSI / ROUTINE TEST PRESSURE: (69) PSI | |
| MIN. THICK. AT: (60) PSI (61) °F | NOTE ANY OTHER BASIS: tm / c | MIN. THICK. AT: (70) PSI (71) °F | NOTE ANY OTHER BASIS: tm / c |
| SHELL | (62) / (63) | CHANNEL | (72) / (73) |
| SHELL COVER | | CHANNEL COVER | |
| SHELL COVER RING | | FLOATING HEAD | |
| SHELL NOZZLE SECTION | | BAFFLE | |
| | | FLT. TUBE SHEET | |
| | | FIXED TUBE SHEET | |
| DESIGN DATA SHEET (74) | | BOLT & GASKET DWG. | |

#### SAFETY PRECAUTIONS (75)

NOTE BELOW ANY SPECIAL HAZARDS, RECOMMENDATIONS, INSPECTIONS OR TESTS THAT ARE IMPORTANT FOR THE ABOVE EQUIPMENT.

(76)

REVISIONS

DRAWN BY ..... DATE ..... (83)
CHECKED BY .....
OPRG. DEPT. BY ..... DATE ..... (82)
ENG. DEPT. BY ..... DATE ..... (82)
APPD. FOR CONSTR. BY ..... DATE ..... (82)
CERTIFIED BY ..... DATE ..... (84)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

| SAFETY INSTRUCTION SHEET - SHELL AND TUBE EXCHANGERS | PLANT NO. | INDEX | DRAWING NO. | SHT NO. | REV. NO. |
|---|---|---|---|---|---|
| (77) | (79) | (80) | DE- (81) | | |
| (78) | | | | | |
| SAUDI ARABIA | JO/EVO – (85) | | | | |

Saudi Aramco 2713-M-ENG (2/90)

## SAUDI ARABIAN OIL COMPANY

### DATA AND OPERATING LIMITS – HEAT EXCHANGERS

#### EQUIPMENT DATA

| | | |
|---|---|---|
| SERVICE: (1) | | ITEM NO.: (2a) |
| MFR.: (3) | SIZE: (4) | PLANT EQUIPM. NO.: (2b) |
| MFR. SERIAL NO.: (6) | ORDER NO.: (7) | TYPE: (5) |
| APPLICABLE CODE & EDITION: (9) | | YEAR BUILT: (8) |
| EQUIPMENT DRAWINGS: (12) | | WEIGHT COMPLETE: (10) WEIGHT BUNDLE: (11) |

#### SHELL SIDE

| | | | | | |
|---|---|---|---|---|---|
| FLUID: (13) | | DIA.: (14) mm D. | mm THICK: (15) | LG.: (16) | MAT'L.: (17) |
| TYPE LONG SEAM: (18) | SR.: (19) | X-RAY: (20) | E (21) % | BASIS FOR CALCULATED TEST PRESSURE (22) kPa(ga) | (23) °C |
| TEST APPLIED NEW: (24) kPa(ga) | LIMITED BY: (25) | | | | |
| COVER | FORM: (26) | MAT'L: (27) mm THICK | RING MAT'L: (28) | | |

#### TUBE SIDE

| | | | | |
|---|---|---|---|---|
| FLUID: (29) | TUBES (30) mm O.D. | (31) BWG | (32) mm LG. | |
| LAYOUT & SPACING: (33) | BASIS FOR CALCULATED TEST PRESSURE (34) kPa(ga) | (35) °C | | |
| TEST APPLIED NEW: (36) kPa(ga) | LIMITED BY: (37) | | | |
| CHANNEL MAT'L: (38) mm THICK | COVER MAT'L: (39) mm THICK | FLT. HD. MAT'L: (40) mm THICK | | |

#### TUBE BUNDLE DETAILS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BUNDLE NO.: (41) | TUBE MAT'L: (42) | | | | | | |
| NO. PER UNIT: (43) | EXT. AREA: (44) $m^2$ | NO. PASS: (45) | NO. PER UNIT: (46) | EXT. AREA: (47) $m^2$ | NO. PASS: (48) | | |
| TUBE SHEET MAT'L: (49) | mm THICK: (50) | TUBE SHEET MAT'L: (51) | mm THICK: (52) | | | | |
| LININGS: (53) | | | | | | | |

#### OPERATING LIMITS

(OPERATING LIMIT REQUIRE OPERATIONS ENGINEERING APPROVAL)

| SHELL | | | TUBES | | | |
|---|---|---|---|---|---|---|
| DESIGN PRESS.: (54) kPa(ga) (55) °C | | | DESIGN PRESS.: (64) kPa(ga) (65) °C | | | |
| BASED ON: (56) | | | BASED ON: (66) | | | |
| PROTECTED BY RELIEF VALVE ON: (57) | | | PROTECTED BY RELIEF VALVE ON: (67) | | | |
| RV. SET AT: (58) kPa(ga) | ROUTINE TEST PRESSURE: (59) kPa(ga) | | RV. SET AT: (68) kPa(ga) | ROUTINE TEST PRESSURE: (69) kPa(ga) | | |
| MIN. THICK. AT: (60) kPa(ga) (61) °C | NOTE ANY OTHER BASIS tm | C | MIN. THICK. AT: (70) kPa(ga) (71) °C | NOTE ANY OTHER BASIS tm | C | |
| SHELL | (62) | (63) | CHANNEL | (72) | (73) | |
| SHELL COVER | | | CHANNEL COVER | | | |
| SHELL COVER RING | | | FLOATING HEAD | | | |
| SHELL NOZZLE SECTION | | | BAFFLE | | | |
| | | | FLT. TUBE SHEET | | | |
| | | | FIXED TUBE SHEET | | | |
| DESIGN DATA SHEET (74) | | | BOLT & GASKET DWG. | | | |

#### SAFETY PRECAUTIONS (75)

NOTE BELOW ANY SPECIAL HAZARDS, RECOMMENDATIONS, INSPECTIONS OR TESTS THAT ARE IMPORTANT FOR THE ABOVE EQUIPMENT.

(76)

REVISIONS

DRAWN BY ..... DATE ..... (83)
CHECKED BY .....

OPRG. DEPT. BY ..... DATE ..... (82)

ENG. DEPT. BY ..... DATE ..... (82)

APPD. FOR CONSTR. BY ..... DATE ..... (82)

CERTIFIED BY ..... DATE ..... (84)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

| | PLANT NO. | INDEX | DRAWING NO. | SHT NO. | REV. NO. |
|---|---|---|---|---|---|
| SAFETY INSTRUCTION SHEET - SHELL AND TUBE EXCHANGERS (77) | (79) | (80) | DE- (81) | | |
| (78) | | | | | |
| SAUDI ARABIA | JO/EVO – (85) | | | | |

## Attachment E-2: Completion of Form 6238-ENG & 6238-M-ENG

| | |
|---|---|
| 1 | Engineering Plant number followed by "-E-" and followed by sequence number: e.g., 11-E-4. |
| 2 | Give short but comprehensive description covering use or function of exchanger; e.g., crude bottoms cooler, debutanizer overhead condenser. |
| 3 | Accounting Plant No. (to be completed by the user). |
| 4 | Manufacturer's name and country where fabricated. |
| 5, 6 | From Manufacturer's specification sheet. |
| 7 | Manufacturer's serial number as stamped on name plate. |
| 8 | Saudi Aramco Purchase Order number, including suffix letters such as: DA. HA, TA, NA. |
| 9 | Year built as indicated on name plate. |
| 10 | ASME Code or other whichever is applicable. Show Code Section and year of issue. |
| 11 | Number of units from Manufacturer's data and/or from Saudi Aramco Specification Sheet, Form 2716-ENG & 2716-M-ENG, Indicate number of units parallel and/or series. |
| 12 | Major Saudi Aramco drawings and foreign print numbers. |
| 13 | Number of sections per unit from Manufacturer's data and/or from Form 2716-ENG & 2716-M-ENG. Indicate number of sections parallel and/or series. |
| 14 | Additional data required to adequately describe the air cooler. |
| 15 | Total external area from Manufacturer's specification sheet. |
| 16 | Indicate yes if forced draft. |
| 17, 18 | Number of fans and diameter from Manufacturer's data. |
| 19,20,21, 22,23,24 | List motor specification from Manufacturer's data and from Forms 2716-ENG & 2716-M-ENG and the Electric Motor Data Sheet, Form 6234. |

| | |
|---|---|
| 25 | Tube side product stream from Air Cooled Heat Exchanger Specification Sheet, Form 2716-ENG & 2716-M-ENG. |
| 26,27,28, 29,30,31 | Specification of material used, and thickness. |
| 32,33,34, 35,36,37, 38,39,40 | Dimensions from Manufacturer's data and Inspection Reports. |
| 41 | Basis for Calculated Test Pressure to be indicated is the lowest value of all bases for calculated test pressures determined for the various exchanger components subjected to the tube side pressure and temperature. See ASME SEC VIII paragraph UG-99(c), Appendix 3 of ASME SEC VIII. For methods for calculation of header parts see under key numbers 51, 52, and 53. |
| 42 | Design temperature from foreign prints and from Form 2716-ENG & 2716-M-ENG for the subject exchanger. When the service conditions of existing equipment are changed the design temperature shall be 30°C (50°F) or 10% higher than the maximum operating temperature, whichever is larger. |
| 43 | For new equipment indicate the hydrostatic test pressure applied by the Manufacturer as taken from the Inspection Report. For re-rated equipment the test pressure is 1.5 times the design pressure stated under key number 45, adjusted for a test temperature of 38°C (100°F). |
| 44 | Indicate exchanger component having the lowest Basis for Calculated Test Pressure as determined under key number 41. For inservice equipment, use API STD 510 to calculate the minimum required thickness and test pressure. |
| 45 | Design pressure and temperatures from foreign prints and from Form 2716-ENG & 2716-M-ENG for the subject exchanger. When the service conditions of existing equipment are changed the design pressure shall be the maximum inlet pressure plus 100 kPa (15 psi) or 10%, whichever is larger. The design temperature shall be as indicated under key number 42. |
| 46 | Indicate specific operating conditions; e.g., shut off head of 11-G-17, design pressure of 11-C-2. |
| 47 | Location of relief valve. |
| 48 | Setting of relief valve. |
| 49 | 1.5 times the design pressure. |

50 Design pressure and design temperature.

51 Calculate minimum required thickness, ($T_m$), in accordance with ASME SEC VIII, paragraph UG-34(c)(2) equation (a) where factor c = 0.5 and d = inside width of header in the corroded conditions.

52 Calculate ($T_m$) in accordance with ASME SEC VIII, paragraph UG-50, where:

$$T_m = \frac{1.1\ (Pp)}{SE} \qquad (1)$$

$T_m$ = minimum plate thickness in mm (in) before the corrosion allowance is added to both sides.

P = design pressure, MPa(ga) (psig).

p = half the sum of two adjacent spans, all members considered in the corroded condition, in mm (in).

S = maximum allowable stress value, MPa (psi).

E = joint efficiency = 100% for plates in one piece.

53 Calculate $T_m$ in accordance with ASME SEC VIII, paragraph UG-34 and UG-53, where:

$$T_m = d\sqrt{\frac{CP}{SE}} \qquad (2)$$

$T_m$ = minimum plate thickness in mm (in).

d = maximum distance between two partition plates, or between partition and top or bottom plate, whichever is the largest distance, plus twice the corrosion allowance, in mm (in).

C = 0.5.

P = design pressure, MPa(ga) (psig).

S = maximum allowable stress value, MPa (psi).

E = ligament efficiency of tube or plug sheet which is pitch - hole diameter pitch or the applicable formula from paragraph UG-53 in the case of unequal tube and plug hole spacing.

54 Corrosion allowance is actual thickness minus ($T_m$).

55 Drawing number of Design Data Sheet, Form 2716-ENG & 2716-M-ENG.

56 Any particulars that are of interest to Operation, Inspection, and Maintenance.

57 Engineering item number, see under key number 1.

58 Show location and area.

59 Show plant number.

60 Follow usual procedure to obtain drawing number.

61 Engineering concurrence as indicated in Section 4 of this Standard plus Project Manager or Plant Manager's approval, as required.

62 Complete this section showing date prepared and name of originator.

63 Signature of Facility Engineering Division head.

64 Include BI and JO under which the equipment was installed.

REFERENCES:

ASME SEC VIII
SAES Section E

Saudi Aramco 6238-ENG (10/90)

APP'D | CERT. | CHKD. | DESCRIPTION | NO. 3 2 1 | REVISIONS

DRAWN BY
DATE (62)
CHK'D BY
APPROVED
ENG. DEPT.
(61)
OPR'G DEPT.
(61)
CERTIFIED
BY
DATE (63)

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED.

JOB ORDER NO. (64)

## SAUDI ARABIAN OIL COMPANY

### DATA AND OPERATING LIMITS - AIR-COOLED HEAT EXCHANGERS

EQUIPMENT DATA — ITEM NO. (1)

| | | |
|---|---|---|
| Service: (2) | | Plant Equipment No.: (3) |
| Manufacturer: (4) | Model: (5) | Type: (6) |
| Mfr. Serial No.: (7) | Order No.: (8) | Year Built: (9) |
| Applicable Code & Edition: (10) | | Number of Units: (11) |
| Equipment Drawings: (12) | | Number of Sections per Unit: (13) |
| (14) | | Total External Area: (15) ft² |

**AIR SIDE**

| | | | | | | |
|---|---|---|---|---|---|---|
| Forced Draft: (16) | No. of Fans: (17) | | Fan Diameter: (18) | | | |
| Motor Type: (19) | (20) HP | (21) R.P.M. | (22) Volts | (23) Phase | (24) Cycle | |

**TUBE SIDE**

| | | | | | |
|---|---|---|---|---|---|
| Fluid: (25) | | TUBES | (32) inch O.D. | (33) Bwg. | (34) inch Lg. |
| Header Material: (26) | END PLATE (27) inch Thick | Layout & Spacing: (35) | | Fins per inch: (36) | |
| Top. Bottom Plate: (28) | PARTITION PLATE (29) inch Thick | Tube Material: (37) | | | |
| Tube & Plug Sheets: (30) inch Thick | | No. per Unit: (38) | Ext. Area: (39) ft² | No. Pass: (40) | |
| Plug Mat'l. & Size: (31) inch | | Basis for Calculated Test Press.: (41) PSIG | | (42) °F | |
| Test Applied New: (43) PSIG | Limited By: (44) | | | | |

**OPERATING LIMITS**
(CONSULT DESIGN ENGINEER BEFORE EXCEEDING THESE LIMITS)

| | |
|---|---|
| Design Pressure (45) PSIG °F | Based on: (46) |
| Protected by Relief Valve on: (47) | R.V. Set at: (48) PSIG — Routine Test Press: (49) PSIG |

| INLET OR NOZZLE HEADER — Min. Thick. at: (50) PSIG °F | NOTE ANY OTHER BASIS TM | C | OUTLET OR RETURN HEADER — Min. Thick. at: (50) PSIG °F | NOTE ANY OTHER BASIS TM | C |
|---|---|---|---|---|---|
| Top Bottom Plates | (51) | (54) | Top Bottom Plates | (51) | (54) |
| End Plates | (51) | | End Plates | (51) | |
| Partitions | (52) | | Partitions | (52) | |
| Plug Sheet | (53) | | Plug Sheet | (53) | |
| Tube Sheet | (53) | | Tube Sheet | (53) | |

DESIGN DATA SHEET: (55)

**SAFETY PRECAUTIONS**

Note below any special hazards, recommendations, inspections or tests that are important for the above equipment.

(56)

| FOR AIR HEAT EXCHANGER | Plant No. | Index | Drawing No. | Sht. No. | Rev. |
|---|---|---|---|---|---|
| (57) (58) SAUDI ARABIA | (59) | A | DE- (60) | of | |

Saudi Aramco 6238-M-ENG (10/90)

| APP'D | | | |
|---|---|---|---|
| CERT. | | | |
| CHKD. | | | |
| DESCRIPTION | | | |
| NO. | 3 | 2 | 1 |

REVISIONS

DRAWN BY
DATE (62)
CHK'D BY

APPROVED
ENG. DEPT.
(61)

OPR'G DEPT.

(61)
CERTIFIED
BY
DATE (63)

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED.

JOB ORDER NO. (64)

## SAUDI ARABIAN OIL COMPANY

### DATA AND OPERATING LIMITS - AIR-COOLED HEAT EXCHANGERS

**EQUIPMENT DATA** — ITEM NO. (1)

| | | | |
|---|---|---|---|
| Service: (2) | | | Plant Equipment No.: (3) |
| Manufacturer: (4) | Model: (5) | | Type: (6) |
| Mfr. Serial No.: (7) | Order No.: (8) | | Year Built: (9) |
| Applicable Code & Edition: (10) | | | Number of Units: (11) |
| Equipment Drawings: (12) | | | Number of Sections per Unit: (13) |
| (14) | | | Total External Area: (15) $m^2$ |

**AIR SIDE**

| | | | | | | |
|---|---|---|---|---|---|---|
| Forced Draft: (16) | No. of Fans: (17) | | Fan Diameter: (18) | | | |
| Motor Type: (19) | (20) kW | (21) R.P.M. | (22) Volts | (23) Phase | (24) Cycle | |

**TUBE SIDE**

| | | | | | |
|---|---|---|---|---|---|
| Fluid: (25) | | TUBES (32) mm O.D. | (33) Bwg. | (34) mm Lg. | |
| Header Material: (26) | END PLATE (27) mm Thick | Layout & Spacing: (35) | | Fins per cm: (36) | |
| Top. Bottom Plate: (28) | PARTITION PLATE (29) mm Thick | Tube Material: (37) | | | |
| Tube & Plug Sheets: (30) mm Thick | | No. per Unit: (38) | Ext. Area: (39) $m^2$ | No. Pass: (40) | |
| Plug Mat'l. & Size: (31) mm | | Basis for Calculated Test Press.: (41) kPa(ga) | (42) °C | | |
| Test Applied New: (43) kPa(ga) | Limited By: (44) | | | | |

**OPERATING LIMITS**
(CONSULT DESIGN ENGINEER BEFORE EXCEEDING THESE LIMITS)

| | | | |
|---|---|---|---|
| Design Pressure (45) kPa(ga) °C | | Based on: (46) | |
| Protected by Relief Valve on: (47) | | R.V. Set at: (48) PSIG | Routine Test Press: (49) PSIG |

| INLET OR NOZZLE HEADER | | | OUTLET OR RETURN HEADER | | |
|---|---|---|---|---|---|
| Min. Thick. at: (50) kPa(ga) °C | NOTE ANY OTHER BASIS TM | C | Min. Thick. at: (50) kPa(ga) °C | NOTE ANY OTHER BASIS TM | C |
| Top Bottom Plates | (51) | (54) | Top Bottom Plates | (51) | (54) |
| End Plates | (51) | | End Plates | (51) | |
| Partitions | (52) | | Partitions | (52) | |
| Plug Sheet | (53) | | Plug Sheet | (53) | |
| Tube Sheet | (53) | | Tube Sheet | (53) | |

DESIGN DATA SHEET: (55)

**SAFETY PRECAUTIONS**

Note below any special hazards, recommendations, inspections or tests that are important for the above equipment.

(56)

| FOR AIR HEAT EXCHANGER | Plant No. | Index | Drawing No. | Sht. No. | Rev. |
|---|---|---|---|---|---|
| (57) (58) SAUDI ARABIA | (59) | A | DE- (60) | of | |

## Attachment F: Completion of Form 2731-ENG & 2731-M-ENG

| | |
|---|---|
| 1 | Give short but comprehensive description. |
| 2 | Plant number followed by the letter "F" and followed by sequence No. e.g., 7-F-301. |
| 3 | Manufacturer's name. |
| 4 | Year built, indicated on name plate, should be year erected on site. |
| 5 | Applicable schematic drawing no. showing all tube numbers. |
| 6 | From Manufacturer's data. |
| 7 | Major Saudi Aramco drawings and foreign print numbers. |
| 8 | Shop hydrostatic test pressure as specified in inspection report and/or Vendor's test certificate. |
| 9 | Pressure at which tightness test was made. Usually, this is the higher design pressure shown under 28 or 30 but may be the same pressure as under 8. |
| 10 | Limiting part or section, also indicate applicable code. |
| 11 | Location, e.g., bank between drums. |
| 12 | Purchase order number for tubes. |
| 13 | Type of material, e.g., stainless steel, 5 Cr ½ Mo. |
| 14 | ASTM specification and grade of tube material. |
| 15 | Number of tubes per size, e.g., 130-3 inch and 559-2 inch. |
| 16 | List required information for all sizes tubes. |
| 17 | One end at tubes, both ends, 4 tubes per header, or other description. |
| 18 | Purchase order number for headers and fittings. |
| 19 | Name of Manufacturer of headers and fittings. |
| 20 | Header types; Manufacturer's type reference. |
| 21 | ASTM specification or equivalent, and grade of header and fitting material. |

| | |
|---|---|
| 22 | ASTM specification or equivalent, and grade holding members and screws. |
| 23 | Inlet, outlet, cross-over, or other location. |
| 24 | Flange size and ANSI class for nozzles. |
| 25 | Facing for all flanges. |
| 26 | Pipe size and weight, schedule No., or wall thickness. |
| 27 | Manufacturer's ratings or ANSI B16.5 flanges. |
| 28, 29, 30, & 31 | Inlet and outlet design pressures and temperatures. |
| 32 | Basis for the data under 28, 29, 30, 31, i.e., operating requirements and applicable code. |
| 33 | Temperature shall be based on SAES-F-001 and API STD 530, or ASME SEC I as applicable. |
| 34 | Indicate location, e.g., crossover, outlet, reactor inlet. |
| 35 | Set pressure of Safety Valve. |
| 36 | 1.5 times design pressure shown under key number 28 or indicate basis. |
| 37 | 1.10 times inlet pressure, key number 28. |
| 38 | List all tube outside diameters. |
| 39 | Minimum tube wall thickness calculated in accordance with SAES-F-001, API STD 530, or ASME SEC I as applicable for the different tube sizes. |
| 40 | Available corrosion allowance. This is difference between wall thickness under key number 16 and ($t_m$) under key number 39. |
| 41, 42 | Pressure and temperature at which ($t_m$) under key number 39 is given. |
| 43 | List all headers. |
| 44 | Minimum header wall thickness calculated in accordance with the ASME Boiler Code or with SAES-F-001 as applicable. |
| 45 | Available corrosion allowance on header walls. |
| 46, 47 | Pressure and temperature at which ($t_m$) under key number 44 is given. |

48 In addition to special safety precautions list any special features and limitations of the equipment that are important to inspection or maintenance.

49 Indicate the standards and/or codes that ($t_m$) under key numbers 39 and 44 were based on such as API STD 530.

50 Show equipment number, per key number 2 above.

51 District and location.

52 Show plant number.

53 Follow usual procedure to obtain drawing numbers.

54 Engineering concurrence as indicated in Section 4 of this standard plus Project Manager or Plant Manager's approval, as required.

55 Complete this section showing date and name of originator.

56 Signature of Facility Engineering Division head.

57 Include BI and JO under which the equipment was installed.

REFERENCES:

ASME SEC I
API STD 530
SAES-F-001

Saudi Aramco 2731-ENG (4/91)

APP'D | CERT. | CHKD. | DESCRIPTION | JO/EWO | BY | DATE | NO. | REVISIONS

**SAUDI ARABIAN OIL COMPANY**

**DATA AND OPERATING LIMITS - FIRED HEATERS**

**EQUIPMENT DATA**

SERVICE (1) NO. (2)

MFR (3) YEAR BUILT (4)

TUBE NUMBERING DIAGRAM (5) EXT HEATING SURFACE (6) SQ. FT.

DRAWINGS (7)

TEST APPLIED NEW: STRENGTH (8) psig LEAKAGE (9) psig

LIMITED BY (10)

| | | | | |
|---|---|---|---|---|
| TUBES: LOCATION, i.e., BANK OR COIL | (11) | (11) | (11) | (11) |
| ORDER NO. | (12) | | | |
| MATERIAL | (13) | | | |
| SPEC. & GRADE | (14) | | | |
| NUMBER | (15) | | | |
| O.D. WALL, AVG OR MIN. LENGTH | (16) | | | |
| | (16) | | | |
| HEADERS & FITTINGS: LOCATION | (17) | | | |
| ORDER NO. | (18) | | | |
| MANUFACTURER | (19) | | | |
| TYPE | (20) | | | |
| MAT'L HEADERS & PLUGS | (21) | | | |
| MAT'L HOLDING MEMBERS & SCREWS | (22) | | | |
| | (22) | | | |
| INLETS, OUTLETS & CROSSOVERS: LOCATION | (23) | | | |
| FLANGE SIZE & ANSI CLASS | (24) | | | |
| FLANGE FACING | (25) | | | |
| CROSSOVER SIZE & WEIGHT | (26) | | | |
| CROSSOVER FITTINGS: RATINGS | (27) | | | |

**OPERATING LIMITS**

(CONSULT DESIGN ENGINEER BEFORE EXCEEDING THESE LIMITS)

DESIGN PRESS: INLET (28) psig (29) °F OUTLET (30) psig (31) °F

BASED ON (32)

MAX. ALLOW. TUBE WALL TEMP. (33)

PROTECTED BY SAFETY VALVE ON (34) S V SET AT (35) psi

TEST PRESSURES: STRENGTH (36) psig LEAKAGE (37) psi

MINIMUM THICKNESS OF TUBES AND HEADERS AT PRES & METAL TEMP. GIVEN

| TUBES | $t_m$* | c | PRES | TEMP. | HEADERS | $t_m$* | c | PRES | TEMP. |
|---|---|---|---|---|---|---|---|---|---|
| (38) | (39) | (40) | (41) | (42) | (43) | (44) | (45) | (46) | (47) |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

DRAWN BY ..... DATE (55) CHKD BY .....

OPRG. DEPT. BY ..... DATE (54)

ENG. DEPT. BY ..... DATE (54)

APPD. FOR CONSTR. BY ..... DATE (54)

CERTIFIED BY ..... DATE (56)

**SAFETY PRECAUTIONS**

NOTE BELOW ANY SPECIAL HAZARDS, RECOMMENDATIONS, INSPECTIONS, OR TESTS THAT ARE IMPORTANT FOR THE ABOVE EQUIPMENT: (48)

* $t_m$ BASED ON: (49)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

SAFETY INSTRUCTIONS SHEET - FIRED HEATERS (50) (51) SAUDI ARABIA

| PLANT NO. | INDEX | DRAWING NO. | SHT. NO. | REV. NO. |
|---|---|---|---|---|
| (52) | A | E - (53) | | |
| JO/EWO - (57) | | | | |

Saudi Aramco 2731-M-ENG (2/90)

# SAUDI ARABIAN OIL COMPANY

## DATA AND OPERATING LIMITS - FIRED HEATERS

APP'D | CERT. | CHKD. | DESCRIPTION | JO/EWO | BY | DATE | NO.

### EQUIPMENT DATA

SERVICE (1) NO. (2)

MFR (3) YEAR BUILT (4)

TUBE NUMBERING DIAGRAM (5) EXT HEATING SURFACE (6) $m^2$

DRAWINGS (7)

TEST APPLIED NEW: STRENGTH (8) kPa(ga) LEAKAGE (9) kPa(ga)

LIMITED BY (10)

| | | | | |
|---|---|---|---|---|
| TUBES: LOCATION, i.e., BANK OR COIL | (11) | (11) | (11) | (11) |
| ORDER NO. | (12) | | | |
| MATERIAL | (13) | | | |
| SPEC. & GRADE | (14) | | | |
| NUMBER | (15) | | | |
| O.D. WALL, AVG OR MIN. LENGTH | (16) | | | |
| | (16) | | | |
| HEADERS & FITTINGS: LOCATION | (17) | | | |
| ORDER NO. | (18) | | | |
| MANUFACTURER | (19) | | | |
| TYPE | (20) | | | |
| MAT'L HEADERS & PLUGS | (21) | | | |
| MAT'L HOLDING MEMBERS & SCREWS | (22) | | | |
| | (22) | | | |
| INLETS, OUTLETS & CROSSOVERS: LOCATION | (23) | | | |
| FLANGE SIZE & ANSI CLASS | (24) | | | |
| FLANGE FACING | (25) | | | |
| CROSSOVER SIZE & WEIGHT | (26) | | | |
| CROSSOVER FITTINGS: RATINGS | (27) | | | |

### OPERATING LIMITS

(CONSULT DESIGN ENGINEER BEFORE EXCEEDING THESE LIMITS)

DESIGN PRESS: INLET (28) kPa(ga) (29) °C OUTLET (30) kPa(ga) (31) °C

BASED ON (32)

MAX. ALLOW. TUBE WALL TEMP. (33)

PROTECTED BY SAFETY VALVE ON (34) S V SET AT (35) kPa(ga)

TEST PRESSURES: STRENGTH (36) kPa(ga) LEAKAGE (37) kPa(ga)

MINIMUM THICKNESS OF TUBES AND HEADERS AT PRES & METAL TEMP. GIVEN

| TUBES | $t_m$* | c | PRES | TEMP. | HEADERS | $t_m$* | c | PRES | TEMP. |
|---|---|---|---|---|---|---|---|---|---|
| (38) | (39) | (40) | (41) | (42) | (43) | (44) | (45) | (46) | (47) |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

REVISIONS

DRAWN BY ..... DATE (55)

CHKD BY .....

OPRG. DEPT. BY ..... DATE (54)

ENG. DEPT. BY ..... DATE (54)

APPD. FOR CONSTR. BY ..... DATE (54)

CERTIFIED BY ..... DATE (56)

### SAFETY PRECAUTIONS

NOTE BELOW ANY SPECIAL HAZARDS, RECOMMENDATIONS, INSPECTIONS, OR TESTS THAT ARE IMPORTANT FOR THE ABOVE EQUIPMENT: (48)

* $t_m$ BASED ON: (49)

THIS DRAWING IS NOT TO USED FOR CONSTRUCTION OR FOR ORDERING MATERIALS UNTIL CERTIFIED AND DATED

SAFETY INSTRUCTIONS SHEET - FIRED HEATERS (50) (51) SAUDI ARABIA

| PLANT NO. | INDEX | DRAWING NO. | SHT. NO. | REV. NO. |
|---|---|---|---|---|
| (52) | A | DE - (53) | | |
| JO/EWO - (57) | | | | |