

# Engineering Standard

SAES-D-008

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## Repairs, Alterations, and Re-rating of Process Equipment

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## Saudi Aramco DeskTop Standards

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## 1 Scope

- 1.1 This standard covers the mandatory engineering requirements for the repair, alteration and rating of in-service pressure vessels, heat exchangers, fired heaters and boilers (herein referred to as *Process Equipment*), manufactured in accordance with ASME Boiler and Pressure Vessel and API Codes and used for all services.
- 1.2 This standard includes items associated with repairs, alterations and re-rating of process equipment such as calculations, approvals, responsible organizations, materials, welding, postweld heat treatment, inspection, pressure testing, documentation and nameplates.
- 1.3 Engineering evaluations such as fitness-for-service or other appropriate methodology based on established practices can be utilized to exempt repairs, alteration or replacement. The procedure and acceptance criteria for conducting these evaluations are not included in this standard. Such evaluations shall be performed by an engineer experienced in design and evaluation of process equipment covered by this standard.

## 2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), industry codes and standards, and Saudi Aramco Standard Drawings (SASDs) and Forms, shall be resolved in writing by the 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 required 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 Standards (SAES)  
[SAES-A-004](#)                      *Pressure Testing*

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|                                   |  |
|-----------------------------------|--|
| <a href="#"><u>SAES-A-005</u></a> | <i>Safety Instruction Sheet</i>                            |
| <a href="#"><u>SAES-A-007</u></a> | <i>Hydrostatic Testing and Lay-Up Procedure</i>            |
| <a href="#"><u>SAES-A-206</u></a> | <i>Positive Material Identification</i>                    |
| <a href="#"><u>SAES-D-001</u></a> | <i>Design Criteria for Pressure Vessels</i>                |
| <a href="#"><u>SAES-D-101</u></a> | <i>Regulated Vendor List for pressure Vessel and Tanks</i> |
| <a href="#"><u>SAES-E-004</u></a> | <i>Design Criteria for Shell and Tube Heat Exchangers</i>  |
| <a href="#"><u>SAES-E-006</u></a> | <i>Design Criteria for Double Pipe Heat Exchangers</i>     |
| <a href="#"><u>SAES-E-007</u></a> | <i>Design Criteria for Air-Cooled Heat Exchangers</i>      |
| <a href="#"><u>SAES-E-014</u></a> | <i>Design Criteria for Plate-and-Frame Heat Exchangers</i> |
| <a href="#"><u>SAES-E-015</u></a> | <i>Design Criteria for Electric Heat Exchangers</i>        |
| <a href="#"><u>SAES-E-101</u></a> | <i>Regulated Vendor List for Heat Transfer Equipment</i>   |
| <a href="#"><u>SAES-F-001</u></a> | <i>Design Criteria of Fired Heaters</i>                    |
| <a href="#"><u>SAES-W-010</u></a> | <i>Welding Requirements for Pressure Vessels</i>           |
| <a href="#"><u>SAES-W-014</u></a> | <i>Weld Overlays and Welding Clad Materials</i>            |
| <a href="#"><u>SAES-W-015</u></a> | <i>Strip Lining Applications</i>                           |

Saudi Aramco Engineering Procedures (SAEP)

|                                 |  |
|---------------------------------|--|
| <a href="#"><u>SAEP-20</u></a>  | <i>Equipment Inspection Schedule</i>   |
| <a href="#"><u>SAEP-302</u></a> | <i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i> |
| <a href="#"><u>SAEP-317</u></a> | <i>Testing and Inspection of Shell and Tube Heat Exchangers</i>                                |
| <a href="#"><u>SAEP-325</u></a> | <i>Inspection Requirements for Pressurized Equipment</i>                                       |
| <a href="#"><u>SAEP-327</u></a> | <i>Disposal of Wastewater from Cleaning, Flushing, and Dewatering Pipelines and Vessels</i>    |

Saudi Aramco Materials System Specification (SAMSS)

|                                     |  |
|-------------------------------------|--|
| <a href="#"><u>32-SAMSS-021</u></a> | <i>Manufacture of Industrial Boilers</i> |
|-------------------------------------|--|

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### 3.2 Industry Codes and Standards

#### American Petroleum Institute (API)

|                    |   |
|--------------------|---|
| <i>API STD 510</i> | <i>Pressure Vessel Inspection Code: Maintenance, Inspection, Rating, and Alteration</i> |
| <i>API STD 530</i> | <i>Calculation of Heater Tube Thickness in Petroleum Refineries</i>                     |
| <i>API STD 560</i> | <i>Fired Heaters for General Refinery Service</i>                                       |
| <i>API STD 660</i> | <i>Shell and Tube Heat Exchangers for General Refinery Service</i>                      |
| <i>API STD 661</i> | <i>Air-Cooled Heat Exchangers for General Refinery Service</i>                          |
| <i>API STD 662</i> | <i>Plate Heat Exchangers for General Refinery Service</i>                               |

#### American Society of Mechanical Engineers (ASME)

|                         |  |
|-------------------------|--|
| <i>ASME SEC I</i>       | <i>Power Boilers</i>   |
| <i>ASME SEC II</i>      | <i>Material Specifications</i>                                       |
| <i>ASME SEC VII</i>     | <i>Recommended Guidelines for the Care of Power Boilers</i>          |
| <i>ASME SEC VIII D1</i> | <i>Rules for Construction of Pressure Vessels</i>                    |
| <i>ASME SEC VIII D2</i> | <i>Rules for Construction of Pressure Vessels, Alternative Rules</i> |

#### American National Standards Institute (ANSI)

|                   |                                       |
|-------------------|---------------------------------------|
| <i>ANSI NB-23</i> | <i>National Board Inspection Code</i> |
|-------------------|---------------------------------------|

## 4 Definitions

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

**Alterations:** A physical change in any component or a re-rating that has design implications that affect the pressure-containing capability of process equipment beyond the scope of the items described in the original Manufacturers' Data Report.

**Authorized Saudi Aramco Inspector:** Saudi Aramco Inspector who is qualified and maintains valid certification according to API STD 510 or ANSI NB-23 (hereinafter specified as NB-23) to perform direct and monitor inspection activities and

documentation on repairs, alterations and re-rating of pressure vessels and/or industrial boilers.

**Boilers:** Industrial fire tube and water tube type boilers designed and fabricated per ASME SEC I. Sanitary and domestic hot water boilers are excluded.

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

**Corrosion Allowance (C):** The corrosion allowance is any metal thickness in excess of the calculated minimum required thickness. Cladding used in process equipment shall be considered only as corrosion allowance and not for additional strength.

**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 Section VIII.

**Design Pressure and Temperature:** The pressure and temperature design conditions specified on the equipment data sheet, which will be used for procurement and fabrication of the process equipment.

**Field:** Any location where process equipment repair work is performed, other than in a Shop.

**Fired Heaters:** Include all equipment that perform heat transfer from combustion to process fluid in tubes by direct radiation and convection, within the scope of API STD 560.

**Heat Exchangers:** Include: shell and tube heat exchangers, air-cooled exchangers, electric heat exchangers, double-pipe exchangers and plate-and-frame heat exchanger designed and fabricated per ASME SEC VIII Division 1 or 2, TEMA, API Standards 660, 661 or 662.

**Hydrogen Services:** process streams containing relatively pure hydrogen and component streams containing hydrogen at a partial pressure of 350 kPa absolute (50 psia) and higher.

**Manufacturer's Data Report:** An ASME Code document completed and furnished by the Manufacturer, certifying all materials, construction and workmanship conforming to Code requirements.

**Maximum Allowable Working Pressure (MAWP):** The maximum permissible gauge pressure at the top of ASME Code Section I and VIII equipment for a designated temperature. It is calculated per the applicable code, using the available thickness exclusive of thickness designated for corrosion and loadings other than pressure.

**Minimum Thickness:** Thickness required for withstanding all primary loads (pressure, wind, seismic, etc.), excluding allowance for corrosion.

**National Board Authorized Inspector:** Non-Saudi Aramco inspector employed by an authorized inspection agency that is qualified and certified according to NB-23 to perform direct and monitor inspection activities and documentation on repairs, alterations and re-rating of pressure vessels and/or industrial boilers.

**Owner-User:** The Owner-User as referenced in API STD 510 and ANSI NB-23 shall be the Superintendent of the Operations Engineering Division of the respective plant or a suitable alternate as appointed by the Plant Manager.

**Pressure Vessels:** Include vertical and horizontal vessels, reactors, columns and drums within the scope of ASME SEC VIII Division 1 or 2.

**Re-rating:** Change in the design temperature and/or MAWP of process equipment. The MAWP and design temperature may be increased or decreased because of re-rating, and sometimes a re-rating requires a combination of changes. Re-rating below original design conditions is a permissible way to provide for corrosion.

**Repair:** The work necessary to restore process equipment to a condition suitable for safe operation at the design conditions, without any deviation from the original configuration.

**Routine Repair:** Repair that does not require "R" stamping in accordance with the NB-23 and PWHT.

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

**Shop:** ASME R-Stamp authorized shop, including manufacturers per [SAES-D-101](#) and [SAES-E-101](#), engaged in repairs, tests and/or alterations of process equipment.

**Utility Services:** Includes: water, steam and nitrogen.

**Wet Sour Services:** Following process streams containing water and hydrogen sulfide:

1. Sour water with a hydrogen sulfide concentration above 2 milligrams per liter with a total partial pressure of 450 kPa absolute (65 psia) or greater.
  2. Crude containing hydrogen sulfide when transported or processed prior to completion of stabilization.
  3. Gas or hydrocarbon condensate containing hydrogen sulfide with a total partial pressure of 450 kPa absolute (65 psia), when transported or processed prior to completion of sweetening or hydrogen sulfide stripping.
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4. Multiphase services when the partial pressure of hydrogen sulfide is above 0.34 kPa absolute (0.05 psia) in the gas phase or a concentration of hydrogen sulfide above 2 milligrams per liter in the water phase.

**Wet Sour HIC Services:** All the above Wet Sour Services where the H<sub>2</sub>S concentration in the water phase is above 50 milligrams per liter.

*Exception:*

*Lean and rich DGA services, other lean amine services, and caustic services are not included in "wet sour" or "wet sour HIC" services.*

## 5 Owner-User Organizations

- 5.1 It is the Owner-User Organization's responsibility to assure all inspection efforts are performed by qualified personnel and all procedures comply with relevant requirements of applicable ASME, API and NB Codes as well as applicable Saudi Aramco documents.
  - 5.2 Saudi Aramco facilities or contractor shops that take the responsibility of performing repairs and/or alteration on pressure vessels and/or industrial boilers are responsible for developing, documenting, implementing, executing, and assessing relevant inspection systems and inspection procedures that will meet the intent of API STD 510 and/or ANSI NB-23. These systems and procedures shall be approved by the Inspection Department and be contained in a quality assurance manual (QAM). The manual shall include the following:
    - a) Organization chart of the structure for inspection personnel and other individuals that perform functions that can affect quality of the repair or alterations.
    - b) Documentation of the specific repair/alteration scope of work the facility is capable of performing.
    - d) Documentation and maintenance of inspections and quality assurance procedures including procedures covering material identification and methods for performing the work.
    - d) Documentation and reports of inspection and test results including pressure tests.
    - e) Corrective action for non-conforming items resulting from inspection and test results.
    - f) Internal audits for assessing compliance with the repair/alteration quality assurance manual.
    - g) Review and approval of drawings, design calculations, and specifications for repairs, alterations, and re-rating.
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- h) Training requirements for inspection personnel regarding inspection tools, techniques, and technical knowledge base.
  - i) Controls necessary so that only qualified welders and welding procedure specification (WPS) are used for all repairs and alteration.
  - j) Controls necessary so that only approved heat treatment method, personnel and procedure are used.
  - k) Controls necessary so that only qualified nondestructive examination (NDE) personnel and procedure are utilized.
  - l) Controls necessary so that only materials conforming to the applicable Code are utilized.
  - m) Controls necessary that all inspection measurement and test equipment are properly maintained and calibrated.
  - n) Internal auditing requirements for the quality system for pressure-relieving devices.
  - o) Controls necessary so that the work of contracted inspection or repair/alterations contractor meet the same requirements as the owner-user organization defined in this standard.
- 5.3 Authorized Saudi Aramco Inspector or National Board Authorized Inspector shall be responsible for determining that the requirements of API STD 510 and/or ANSI NB-23 on inspection, examination, and testing of repairs or alterations are met. The inspector shall be directly involved in all inspection planning, execution and related activities. All examinations and testing results must be evaluated and accepted by the Authorized Saudi Aramco Inspector or National Board Authorized Inspector.
- 5.4 Saudi Aramco facilities shall maintain the following records related to the operation, inspection, and maintenance history in the Equipment File:
- a) Construction drawings, original design specification data, manufacturers' data reports.
  - b) Operating and inspection history. For example, operating conditions, including process upsets that may affect integrity, inspection reports, and data for each type of inspection conducted (for example, internal, external, thickness measurements).
  - c) Repair, alteration, and re-rating information per Appendices A, B, C or D of this standard shall be completed and included in the Equipment File.
  - d) Documentation for equipment undergoing Fitness-For-Service (FFS) assessment, including inspection data used in the FFS calculations, assumptions and analysis results.
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## 6 Repairs

- 6.1 All welding, weld procedures, welder qualifications records, post weld heat treatment shall comply with the applicable Saudi Aramco Engineering Standards.
- 6.2 A complete document package of repairs in paragraphs 6.6.3, 6.6.4, 6.6.7, 6.6.11, 6.6.12, and 6.6.15 of this standard shall be submitted to the Supervisor of the Process Equipment Unit of CSD, prior to the start of field work with sufficient time for approval. The need to submit a package of repairs that are not listed in paragraph 6.6 of this standard shall be determined on a case-by-case basis. The document package shall include:
- Original general arrangement drawings.
  - Safety Instruction Sheet.
  - Applicable Code calculations.
  - Material designations and thickness for nozzles, manways or shell or head sections.
  - NDE and weld maps, if applicable.
  - Welding Procedures, if applicable.
  - PWHT Procedures, if applicable.
  - Testing and Inspection Plan, if applicable.
  - Pressure testing plan, if applicable.
  - A complete inspection report addressing the current condition of the pressure components and attachments.
- 6.3 Repairs can be performed in accordance with the applicable Code revision to which the item was originally fabricated. Otherwise, the current revision of the applicable ASME or API Code must be followed.
- 6.4 Overlap welded patch repairs are not permitted.
- 6.5 A record of the repair per Appendices A, B, C or D as applicable shall be completed and included in the local Plant Equipment Inspection File.
- 6.6 Following are typical examples of repairs:
- 6.6.1 The addition, repairs or replacement of structural attachments welded to pressure parts, such as:
- a. Studs for insulation or refractory lining.
  - b. Hex steel or expanded metal for refractory lining.
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- c. Ladder clips.
  - d. Brackets.
  - e. Tray support rings.
- 6.6.2 Corrosion-resistant strip lining.
- 6.6.3 Corrosion-resistant weld overlay exceeding total of 100 in<sup>2</sup>.
- 6.6.4 Weld buildup of wasted areas (locally corroded or eroded areas), exceeding the limits specified in paragraph 6.6.16(1) of this standard, to restore and maintain the pressure retaining component such that it is fit for service.
- 6.6.5 Replacement of heat exchanger tube sheets in accordance with the original design;
- 6.6.6 Replacement of boiler and heat exchanger tubes where welding or tube expansion is involved;
- 6.6.7 The replacement of a shell course or head in a pressure vessel;
- 6.6.8 Welding of gage holes;
- 6.6.9 Weld repair or build-up distorted flange faces;
- 6.6.10 Replacement of slip-on flanges with weld neck flanges;
- 6.6.11 Repair or replacement of shell or head sections with a Code accepted material that has a nominal composition and strength that is equivalent to the original material, and is suitable for the intended service;
- 6.6.12 Replacement of shell or head sections with a material of different nominal composition, equal to or greater in allowable stress from that used in the original design, provided the replacement material satisfies the material and design requirements of the original code of construction under which the process equipment was built;
- 6.6.13 Complete or partial replacement of wall tubes, super-heater tubes, bank tubes, and economizer tubes in a boiler.
- 6.6.14 Replacement of pressure retaining parts identical to those existing on the process equipment and described on the original Manufacturers' Data Report. For example:
- a. Replacement of floor tubes and/or sidewall tubes in a boiler.
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- b. Replacement of a section in a shell or head in accordance with the original design.
- c. Re-welding a circumferential or longitudinal seam in a shell or head.
- d. Replacement of nozzles of a size where reinforcement is not a consideration (3 NPS nozzle in a shell or head of 3/8 inch or less in thickness or 2 NPS nozzle in a shell or head of thickness not exceeding 1.5 inches) in vessels that are not in cyclic service.

6.6.15 Replacement of existing or installation of new nozzles or manways in any of the following:

- a) A shell or head of thickness equal to or exceeding 1.5 inches.
- b) Vessels in cyclic service.

*Commentary Note:*

*Structural stability of process equipment needs to be verified and consequently the need for its stiffening is determined when large sections are replaced or openings are installed with dimensions exceeding 12 inches or a 45-degree arc, whichever is smaller, in the circumferential direction.*

6.6.16 Routine Repairs

Following are examples of routine repairs:

- 1) Weld buildup of wasted areas (corroded or eroded) in shells and heads not exceeding 100 in<sup>2</sup> with depth no more than 25% of nominal wall thickness or 1/2 inch, whichever is less, and where PWHT is not required.
- 2) Corrosion resistance weld overlay not exceeding 100 in<sup>2</sup>, where PWHT is not required.
- 3) Weld repairs not exceeding 25% of the nominal wall thickness or 0.5 inch, whichever is less, in equipment not in cyclic service.

## 7 Alterations of Process Equipment

7.1 A complete document package of the proposed alteration shall be submitted to the Supervisor, Process Equipment Unit of CSD, prior to the start of field work with sufficient time for approval. The document package shall include:

- Original and proposed general arrangement drawings.
  - Safety Instruction Sheets.
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- Applicable Code calculations.
  - Material designations and thickness for all pressure components, supports, welded attachments and internals.
  - NDE and weld maps, if applicable.
  - Welding Procedures, if applicable.
  - PWHT Procedures, if applicable.
  - Pressure testing plan, if applicable.
  - Testing and Inspection Plan, if applicable.
  - A complete inspection report addressing the current condition of the pressure components and attachments.
- 7.2 All alterations shall comply with the latest revision of the applicable design Code and Saudi Aramco standards currently in effect.
- 7.3 Process equipment proposed for alteration shall be fully inspected both internally and externally when accessible. The inspection report shall address the current condition and corrosion history of all pressure components and attachments such that suitability for service assessment can be made with regards to the intended service and Equipment Inspection Schedule.
- 7.4 A record of the alteration per Appendices A, B, C or D shall be completed and included in the Equipment File. A revised Safety Instruction Sheet reflecting alteration that the equipment has undergone shall be completed in accordance with [SAES-A-005](#).
- 7.5 Following are typical examples of alterations:
- 7.5.1 An increase in the maximum allowable working pressure (internal or external) or design temperature of a pressure retaining item regardless of whether or not a physical change was made to the pressure retaining item;
  - 7.5.2 A decrease in the original Minimum Design Metal Temperature (MDMT) such that additional mechanical tests are required;
  - 7.5.3 The addition of new nozzles or openings in a boiler or pressure vessel except those classified as repairs;
  - 7.5.4 A change in the dimensions or contour of a pressure retaining item;
  - 7.5.5 An increase or decrease in any heating surface in a boiler or a fired heater;
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- 7.5.6 The addition of a pressurized jacket to a pressure vessel;
- 7.5.7 Replacement of a pressure retaining part in a pressure retaining item with a material of suitable composition, but less in allowable stress from that used in the original design such that the replacement material does not satisfy the material and design requirement of the original code of construction under which the process equipment was built.

## 8 Re-Rating of Process Equipment

- 8.1 Re-rating reductions in the design temperature and/or MAWP can be considered when remaining corrosion allowance is less than twice the corrosion expected for the next inspection interval as defined in [SAEP-20](#). A reduced inspection interval can also be considered in lieu of a re-rating reduction.
- 8.2 The addition of a new nameplate shall be provided for re-rated process equipment. A revised Safety Instruction Sheet shall reflect the new MAWP and available corrosion allowance shall be completed in accordance with [SAES-A-005](#).
- 8.3 Relief valves shall be re-set to comply with the new MAWP value.

## 9 Postweld Heat Treatment

- 9.1 The requirement of post weld heat treatment (PWHT) shall be based upon the material composition, service fluids, and the maximum thickness of the performed pressure retaining welds and PWHT records. Preheat and controlled deposition welding techniques are not permitted in lieu of PWHT.
- 9.2 PWHT of process equipment undergoing repairs or alterations shall be performed according to the applicable Saudi Aramco Engineering Standards and industry Codes.
- 9.3 For carbon and low alloy steels, the following process conditions require PWHT. Code exemptions for PWHT are not permitted if PWHT is specified for process conditions.
  - 9.3.1 All caustic soda (NaOH) solutions and in conditions including where caustic carryover may occur.
  - 9.3.2 All Di-Ethanol-Amine (DEA) solutions.
  - 9.3.3 All Mono-Ethanol-Amine (MEA) solutions.
  - 9.3.4 All Di-Glycol Amine (DGA) solutions above 138°C design temperature.

- 9.3.5 All rich Amino Di-Isopropanol (ADIP) solutions above 90°C design temperature.
- 9.3.6 All Methyl-Di-Ethanol-Amine (MDEA) solutions, including the activated MDEA solutions.
- 9.3.7 All lean ADIP solutions above 60°C design temperature.
- 9.3.8 Boiler deaerator service for P-No. 1, 3, 4, and 5 A/B/C base materials.
- 9.4 Where localized PWHT is performed on category A or B welded joints, sections with nozzles or manways, other welded attachments in an ASME code, Section VIII vessel, a 360° band of the shell section containing these items shall be heated. PWHT heating band around nozzles or manways or other attachments in heads is permitted.
- 9.5 Localized PWHT at more than one location in the process equipment and other repair/alteration details not covered in this standard shall be allowed when approved by the Supervisor, Process Equipment Unit of CSD.
- 9.6 Adequate support for the pressure equipment, attachments and associated items shall be considered during PWHT. Overall and local buckling shall be considered when assessing stability at higher temperatures. Dead weight and 40% of maximum wind loads shall be used in the analysis. The stability analysis shall be submitted to the Supervisor of the Process Equipment Unit of CSD for approval.

## 10 Pressure Testing

- 10.1 Pressure testing shall be conducted in accordance with the applicable industry standards and as modified and supplemented by this section and applicable Saudi Aramco manufacturing document (SAMSS).

### *Commentary Notes:*

*For ASME Code, Section VIII, Division 1 equipment, testing pressure depends on the Code's edition. For example,*

- 1) *Hydrostatic test pressure for a vessel built prior to the 1999's Code edition is 1.5 times MAWP, while a vessel built to 1999's and consequent editions shall be tested at a pressure equal to 1.3 times MAWP.*
- 2) *Pneumatic test pressure for a vessel built prior to the 1999's Code edition is 1.3 times MAWP, while a vessel built to 1999's and consequent editions shall be tested at a pressure equal to 1.1 times MAWP.*

- 10.2 Hydrostatic testing is required for all repairs and alterations which involve new pressure retaining welds and new pressure components, including but not limited to the following.
    - 10.2.1 Repairs in paragraphs: 6.6.5, 6.6.6, 6.6.7, 6.6.10, 6.6.11, 6.6.12, 6.6.13, 6.6.14, and 6.6.15.
    - 10.2.2 Alterations in paragraphs: 7.5.1, 7.5.3, 7.5.4, 7.5.5, 7.5.6, and 7.5.7.
    - 10.2.3 Increase in the design temperature and/or MAWP of process equipment that meets the definition of an alteration according to Section 4 of this standard.
    - 10.2.4 Decrease in any heating surface in a boiler or a fired heater.
    - 10.2.5 Replacement of girth flange gaskets in shell-and-tube heat exchangers as follows:
      - a) Flanges with more than 30-inch inside diameter, regardless of the service.
      - b) Flanges with equal to or smaller than 30-inch inside diameter in lethal, hydrogen or cyclic services.
  - 10.3 Requirement for hydrostatic testing of equipment that undergoes weld-up repair of wasted areas, per paragraph 6.6.4 of this standard shall be determined on a case-by-case basis.
  - 10.4 Hydrotesting is not required for the entire vessel if a flanged section of the vessel has been hydrotested after undergoing alteration or repair.
  - 10.5 Pneumatic testing in lieu of hydrostatic testing shall only be allowed after approval of the Supervisor, Process Equipment Unit of CSD and the Superintendent of Operations Inspection Division of Inspection Department.
  - 10.6 The test duration shall be one hour per inch wall thickness with a minimum duration of one hour.
  - 10.7 Hydrostatic testing pressure shall be based on current MAWP at the hydrotest temperature.
  - 10.8 The minimum hydrotest water temperature shall be 60°F. The test temperature needs not to exceed 120°F unless there is information on the brittle characteristics of the equipment material indicating that a lower test temperature is acceptable or a higher test temperature is needed. Hydrotest water used for stainless steel equipment or components shall meet the requirements of [SAES-A-007](#).
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- 10.9 100% radiography in lieu of hydrotesting per [SAES-A-004](#) may be substituted for a complete hydrotest of the process equipment only if the new or repaired welds are completely accessible for radiography and comply with one of the following:
- 10.9.1 New welds for replacement of nozzle flanges or attachment of piping to nozzles that are farther than 3 times shell wall thickness measured from the outside surface of the shell, head or other pressure retaining component.
  - 10.9.2 Repairs of defects in pressure retaining welds that do not involve any of the following:
    - a) More than 50% of the minimum wall thickness.
    - b) Total length exceeding 10 times the wall thickness or 20 inches, whichever is less.
- 10.10 Local hydrotesting can be performed for nozzle repairs and alterations. A detailed diagram and procedure for local hydrotesting must be submitted to the Supervisor, Process Equipment Unit of CSD for approval. A test closure fabricated from a pipe cap or head can be attached on the internal surface of the process equipment during the test. The diameter of the closure shall be a minimum of four inches greater than the diameter of repaired or altered nozzle. After removal of the test closure, the attachment welds shall be ground smooth and the area inspected with Magnetic Particle Testing (MP) or Liquid Penetrant Test (LP) for surface defects.
- 10.11 Hydrotesting procedures shall consider the strength of existing foundations under test loads.
- 10.12 Disposal of Hydrotest Water shall be in accordance with [SAEP-327](#).

## 11 Stamping

- 11.1 ASME Section I and VIII equipment that undergo re-rating, alterations or repairs requiring pressure testing (or alternate nondestructive examination allowed per this standard) and performed by Saudi Aramco personnel shall have an additional nameplate adjacent to the original nameplate. The nameplate shall comply with NB-23, except that "R" stamping or certification is not required.
- 11.2 ASME Section I and VIII equipment that undergo re-rating, alterations or repairs requiring pressure testing (or alternate nondestructive examination allowed per this standard) and performed by contractors' shops shall have an additional nameplate adjacent to the original nameplate. The nameplate shall comply with NB-23, Appendix 2, including R-stamping and certificate number.
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A report for the performed repairs or alterations per NB-23, Appendix 5 shall be prepared by the contractors.

- 11.3 Requirements of paragraphs 11.1 and 11.2 of this standard are also applicable to equipment that were designed, fabricated, examined and tested according to ASME Section I and VIII with or without the applicable Code stamp (U, U2, or S).

30 November 2003      **Revision Summary**  
Major revision

**Appendix A**  
**Record of Repair, Re-rating and Alteration for**  
**Pressure Vessels and Shell-and-Tube Heat Exchangers**

|   |                                 |  |                                    |
|---|---------------------------------|--|------------------------------------|
| Vessel Number:  |                                 | Location/Plant Number:                     |                                    |
| Manufacturer:   |                                 | Manufacturer's Serial Number:              |                                    |
| Original Construction Code:   |                                 | Year Built:                                |                                    |
| Original Design Pressure:   |                                 | Original Design Temperature:               |                                    |
| Original Minimum Design Metal Temperature:  |                                 | At Pressure:                               |                                    |
| Material of Shell:  |                                 | Material of Heads:                         |                                    |
|   |                                 |  |                                    |
| Shell Thickness:  |                                 | Head Thickness:                            |                                    |
| Original Joint Efficiency:  |                                 | Original Radiography:                      |                                    |
| Original PWHT:  |                                 | Original Corrosion Allowance:              |                                    |
| Work on Vessel Classified As:   | <input type="checkbox"/> Repair | <input type="checkbox"/> Alteration        | <input type="checkbox"/> Re-rating |
| If Applicable:  |                                 |  |                                    |
| New MAWP:   |                                 | New Design Temperature:                    |                                    |
| New Minimum Design Metal Temperature:   |                                 | At Pressure:                               |                                    |
| New PWHT:   | New Joint Efficiency:           | New Corrosion Allowance:                   |                                    |
| Type of Examination or Inspection Performed:  |                                 |  |                                    |
| <input type="checkbox"/> Radiography:   |                                 | <input type="checkbox"/> Ultrasonic:       |                                    |
| <input type="checkbox"/> Magnetic Particle:   |                                 | <input type="checkbox"/> Liquid Penetrant: |                                    |
| <input type="checkbox"/> Visual:  |                                 | <input type="checkbox"/> Other (Specify):  |                                    |
| Description of Work Performed (Attached Drawings and Calculations)  |                                 |  |                                    |
|   |                                 |  |                                    |
| Pressure Test, if applied: <input type="checkbox"/> Hydrostatic; <input type="checkbox"/> Pneumatic   |                                 |  |                                    |
| <b>STATEMENT OF COMPLIANCE</b>  |                                 |  |                                    |
| We certify that the statements made on this record are correct and that all materials , inspection, and construction of this <input type="checkbox"/> repair, <input type="checkbox"/> re-rating, <input type="checkbox"/> alteration complies with SAES-D-008 issued:_____ |                                 |  |                                    |
| Name: _____   |                                 | Signed: _____ Date: _____                  |                                    |
| ID#: _____  |                                 | (Saudi Aramco Inspector)                   |                                    |
| API cert. #: _____  |                                 | Dated: _____                               |                                    |
| NB com. Card #: _____   |                                 | Dated: _____                               |                                    |
|   |                                 |  |                                    |

**Appendix B**  
**Record of Repair, Re-rating and Alteration**  
**of Air-Cooled and Plate-and-Frame Heat Exchangers**

|   |                                 |  |                                    |
|---|---------------------------------|--|------------------------------------|
| Vessel Number:  |                                 | Location/Plant Number:                     |                                    |
| Manufacturer:   |                                 | Manufacturer's Serial Number:              |                                    |
| Original Construction Code:   |                                 | Year Built:                                |                                    |
| Original Design Pressure:   |                                 | Original Design Temperature:               |                                    |
| Original Minimum Design Metal Temperature:  |                                 | At Pressure:                               |                                    |
| Material of Header:   |                                 |  |                                    |
|   |                                 |  |                                    |
| Header Thickness  |                                 |  |                                    |
| Original Joint Efficiency:  |                                 | Original Radiography:                      |                                    |
| Original PWHT:  |                                 | Original Corrosion Allowance:              |                                    |
| Work on Vessel Classified As:   | <input type="checkbox"/> Repair | <input type="checkbox"/> Alteration        | <input type="checkbox"/> Re-rating |
| If Applicable:  |                                 |  |                                    |
| New MAWP:   |                                 | New Design Temperature:                    |                                    |
| New Minimum Design Metal Temperature:   |                                 | At Pressure:                               |                                    |
| New PWHT:   | New Joint Efficiency:           | New Corrosion Allowance:                   |                                    |
| Type of Examination or Inspection Performed:  |                                 |  |                                    |
| <input type="checkbox"/> Radiography:   |                                 | <input type="checkbox"/> Ultrasonic:       |                                    |
| <input type="checkbox"/> Magnetic Particle:   |                                 | <input type="checkbox"/> Liquid Penetrant: |                                    |
| <input type="checkbox"/> Visual:  |                                 | <input type="checkbox"/> Other (Specify):  |                                    |
| Description of Work Performed (Attached Drawings and Calculations)  |                                 |  |                                    |
|   |                                 |  |                                    |
|   |                                 |  |                                    |
| Pressure Test, if applied: <input type="checkbox"/> Hydrostatic; <input type="checkbox"/> Pneumatic   |                                 |  |                                    |
| STATEMENT OF COMPLIANCE   |                                 |  |                                    |
| We certify that the statements made on this record are correct and that all materials , inspection, and construction of this <input type="checkbox"/> repair, <input type="checkbox"/> re-rating, <input type="checkbox"/> alteration complies with SAES-D-008 issued:_____ |                                 |  |                                    |
| Name: _____   |                                 | Signed: _____ Date: _____                  |                                    |
| ID#: _____  |                                 | (Saudi Aramco Inspector)                   |                                    |
| API cert. #: _____  |                                 | Dated: _____                               |                                    |
| NB com. Card #: _____   |                                 | Dated: _____                               |                                    |
|   |                                 |  |                                    |

## Appendix C

### Record of Repair, Re-rating and Alteration of Boilers

|   |                                 |   |                                    |
|---|---------------------------------|---|------------------------------------|
| Vessel Number:  |                                 | Location/Plant Number:                                |                                    |
| Manufacturer:   |                                 | Manufacturer's Serial Number:                         |                                    |
| Original Construction Code:   |                                 | Year Built:   |                                    |
| Original Design Pressure:   |                                 | Original Design Temperature:                          |                                    |
| Original Minimum Design Metal Temperature:  |                                 | At Pressure:  |                                    |
| Material of Steam Drum Shell:   |                                 | Material of Steam Drum Heads:                         |                                    |
| Material of Water Drum Shell:   |                                 | Material of Water Drum Heads:                         |                                    |
| Shell Thickness/Steam Drum/Water Drum:  |                                 | Head Thickness/Steam Drum/Water Drum                  |                                    |
| Original Joint Efficiency:  |                                 | Original Radiography:                                 |                                    |
| Original PWHT:  |                                 | Original Corrosion Allowance:                         |                                    |
| Work on Vessel Classified As:   | <input type="checkbox"/> Repair | <input type="checkbox"/> Alteration                   | <input type="checkbox"/> Re-rating |
| If Applicable:  |                                 |   |                                    |
| New MAWP:   |                                 | New Design Temperature:                               |                                    |
| New Minimum Design Metal Temperature:   |                                 | At Pressure:  |                                    |
| New PWHT:   | New Joint Efficiency:           | New Corrosion Allowance:                              |                                    |
| Type of Examination or Inspection Performed:  |                                 |   |                                    |
| <input type="checkbox"/> Radiography:   |                                 | <input type="checkbox"/> Ultrasonic:                  |                                    |
| <input type="checkbox"/> Magnetic Particle:   |                                 | <input type="checkbox"/> Liquid Penetrant:            |                                    |
| <input type="checkbox"/> Visual:  |                                 | <input type="checkbox"/> Other (Specify):             |                                    |
| Description of Work Performed (Attached Drawings and Calculations)  |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
| STATEMENT OF COMPLIANCE   |                                 |   |                                    |
| We certify that the statements made on this record are correct and that all materials , inspection, and construction of this <input type="checkbox"/> repair, <input type="checkbox"/> re-rating, <input type="checkbox"/> alteration complies with SAES-D-008 issued:_____ |                                 |   |                                    |
| Name: _____   |                                 | Signed: _____ Date: _____<br>(Saudi Aramco Inspector) |                                    |
| ID#: _____  |                                 |   |                                    |
| API cert. #: _____  |                                 | Dated: _____  |                                    |
| NB com. Card #: _____   |                                 | Dated: _____  |                                    |
|   |                                 |   |                                    |

## Appendix D

### Record of Repairs, Re-rating and Alteration of Fired Heaters

|   |                                 |   |                                    |
|---|---------------------------------|---|------------------------------------|
| Vessel Number:  |                                 | Location/Plant Number:                                |                                    |
| Manufacturer:   |                                 | Manufacturer's Serial Number:                         |                                    |
| Original Construction Code:   |                                 | Year Built:   |                                    |
| Original Design Pressure:   |                                 | Original Design Temperature:                          |                                    |
| Original Minimum Design Metal Temperature:  |                                 | At Pressure:  |                                    |
| Material of Tubes   |                                 |   |                                    |
|   |                                 |   |                                    |
| Tube Thickness:   |                                 |   |                                    |
| Original Joint Efficiency:  |                                 | Original Radiography:                                 |                                    |
| Original PWHT:  |                                 | Original Corrosion Allowance:                         |                                    |
| Work on Vessel Classified As:   | <input type="checkbox"/> Repair | <input type="checkbox"/> Alteration                   | <input type="checkbox"/> Re-rating |
| If Applicable:  |                                 |   |                                    |
| New MAWP:   |                                 | New Design Temperature:                               |                                    |
| New Minimum Design Metal Temperature:   |                                 | At Pressure:  |                                    |
| New PWHT:   | New Joint Efficiency:           | New Corrosion Allowance:                              |                                    |
| Type of Examination or Inspection Performed:  |                                 |   |                                    |
| <input type="checkbox"/> Radiography:   |                                 | <input type="checkbox"/> Ultrasonic:                  |                                    |
| <input type="checkbox"/> Magnetic Particle:   |                                 | <input type="checkbox"/> Liquid Penetrant:            |                                    |
| <input type="checkbox"/> Visual:  |                                 | <input type="checkbox"/> Other (Specify):             |                                    |
| Description of Work Performed (Attached Drawings and Calculations)  |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
| <b>STATEMENT OF COMPLIANCE</b>  |                                 |   |                                    |
| We certify that the statements made on this record are correct and that all materials , inspection, and construction of this <input type="checkbox"/> repair, <input type="checkbox"/> re-rating, <input type="checkbox"/> alteration complies with SAES-D-008 issued:_____ |                                 |   |                                    |
| Name: _____   |                                 | Signed: _____ Date: _____<br>(Saudi Aramco Inspector) |                                    |
| ID#: _____  |                                 |   |                                    |
| API cert. #: _____  |                                 | Dated: _____  |                                    |
| NB com. Card #: _____   |                                 | Dated: _____  |                                    |
|   |                                 |   |                                    |