

Engineering Standard

SAES-A-004

30 March 2005

General Requirements for Pressure Testing

Document Responsibility: Inspection Department

Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This standard defines mandatory general requirements governing in-situ pressure testing of new and existing pipelines, plant piping and pressure containing process equipment (hereinafter called equipment). Specific requirements are covered in the specific SAESs applicable to that equipment or piping system. This standard supplements ASME B31's and other applicable codes.
- 1.2 The requirements of this standard apply to field/shop fabricated piping systems and field fabricated equipment.
- 1.3 This standard does not cover pressure testing of new, shop fabricated equipment such as vessels, tanks, heat exchangers and skid mounted piping which are purchased in accordance with the applicable SAMSS.

Exception:

Fin-fan coolers are to be tested in situ in accordance with paragraph 6.4.5.

- 1.4 This standard applies to pre start-up leak tests normally conducted by Operations during start-up, commissioning and T&I of the facilities in accordance with approved plant operating procedures.
- 1.5 This standard does not apply to equipment as excluded in section 7.2.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAES's), Materials System Specifications (SAMSS's), Standard Drawings (SASD's), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Inspection 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, Inspection 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 Procedures

<u>SAEP-302</u>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
<u>SAEP-327</u>	<i>Disposal of Wastewater from Cleaning, Flushing, and Dewatering Pipelines and Vessels</i>

Saudi Aramco Engineering Standards

<u>SAES-A-005</u>	<i>Safety Instruction Sheet</i>
<u>SAES-A-007</u>	<i>Hydrostatic Testing Fluids and Lay-up Procedures</i>
<u>SAES-B-017</u>	<i>Fire Water Systems</i>
<u>SAES-D-008</u>	<i>Inspection, Repairs, Alteration, Rerating and Testing of Existing Pressured Equipment</i>
<u>SAES-D-108</u>	<i>Storage Tank Testing and Inspection</i>
<u>SAES-H-101</u>	<i>Saudi Aramco Paint and Coating Systems</i>
<u>SAES-K-001</u>	<i>Heating, Ventilating and Air-Conditioning</i>
<u>SAES-L-108</u>	<i>Selection of Valves</i>
<u>SAES-L-150</u>	<i>Pressure Testing of Plant Piping and Pipelines</i>
<u>SAES-L-350</u>	<i>Construction of Plant Piping</i>
<u>SAES-J-901</u>	<i>Instrument Air Supply Systems</i>
<u>SAES-S-020</u>	<i>Industrial Drainage and Sewers</i>
<u>SAES-S-030</u>	<i>Storm Water Drainage</i>
<u>SAES-S-040</u>	<i>Saudi Aramco Water Systems</i>
<u>SAES-S-060</u>	<i>Saudi Aramco Plumbing Code</i>
<u>SAES-S-070</u>	<i>Installation of Utility Piping Systems</i>

Saudi Aramco Materials System Specifications

<u>01-SAMSS-010</u>	<i>Fabricated Carbon Steel Piping</i>
<u>04-SAMSS-048</u>	<i>Valve Testing and Inspection Requirements</i>
<u>32-SAMSS-004</u>	<i>Manufacturing of Pressure Vessels</i>
<u>32-SAMSS-005</u>	<i>Manufacturing of Atmospheric Tanks</i>

[32-SAMSS-006](#)

Manufacturing of Low Pressure Tanks

[32-SAMSS-021](#)

Manufacturing of Industrial Watertube Boilers

[32-SAMSS-029](#)

Manufacturing of Fired Heaters

Saudi Aramco Form and Data Sheet

Form 2642-ENG

Pressure Test Report Form

Saudi Aramco General Instructions

GI-0002.102

Pressure Testing Safely

GI-1781.001

*Inspection, Testing and Maintenance of Fire
Protection Equipment*

Saudi Aramco Bottled Gas Manual Section V

3.2 Industry Codes and Standards

American Petroleum Society

API RP 520

*Part I - Sizing, Selection, and Installation of
Pressure Relieving Devices in Refineries*

American Society of Mechanical Engineers

ASME B31.1

Power Piping

ASME B31.3

Process Piping

ASME B31.4

*Pipeline Transportation Systems for Liquid
Hydrocarbons and Other Liquids*

ASME B31.5

Refrigeration Piping

ASME B31.8

*Gas Transmission and Distribution Piping
Systems*

ASME B31.9

Building Services Piping

ASME SEC V

Article 10 Leak Testing

ASME SEC VI

*Recommended Rules for the Care and Operation
of Heating Boilers*

ASME SEC VIII D1 & 2 Boiler and Pressure Vessel Code

National Board of Boiler and Pressure Vessel Inspectors

NB 23

National Board of Inspection Code

4 Definitions

Hydrostatic Test: A pressure test conducted using water or other approved liquid as the test medium.

Pre Start-up Leak Test: A pressure test to ensure tightness of flanged and threaded joints at the test pressure. It is normally conducted before initial start-up, during commissioning or after T&Is.

Pneumatic Test: A pressure test conducted using air or other approved gas as the test medium or in conjunction with liquid.

Pressure Test: A test conducted to piping or equipment by subjecting it to an internal pressure using liquid or gas to ensure strength or tightness of the system at the test pressure.

Revalidation Test: A pressure test performed to prove the integrity of existing piping or equipment. This test is administered by the proponent organization.

Service Test: A pressure test conducted at operating pressure using the service fluid.

Strength Test: A pressure test at an internal pressure determined in accordance with this standard and the applicable Code to verify the integrity of the piping systems or equipment for service at the design pressure.

System Test: An in-situ pressure test applied to a group of piping and equipment tested as a system.

Pressure Test Procedure. Information assembled to ensure all requirements listed in GI-0002.102 , all referenced Saudi Aramco standards and Industrial standards are met.

Tightness Test: A pressure test to ensure tightness of the piping system (i.e., no leaks in the system) at the test pressure.

5 General Requirements

5.1 General Instruction GI-0002.102 "Pressure Testing Safely" shall be followed during pressure testing.

5.2 Pneumatic testing

5.2.1 Pneumatic testing is not permitted without written approval of the Manager, Inspection Department, unless specifically allowed by this standard or the referenced Saudi Aramco SAESs or SAMSSs. This test, when conducted, shall be in accordance with GI-0002.102 for additional safety requirements.

- 5.2.2 Pneumatic testing with air of piping systems or equipment which have been in flammable service shall be concurred by the Manager, Loss Prevention Department.
- 5.3 The effect of the static head of the testing liquid shall be considered when determining the effective test pressure of any elements within a tested system.
- 5.4 Test pressures and test durations shall be based on the applicable Aramco standards.
- 5.5 Protection from Overpressure

All systems (piping and equipment) while being pressure tested shall be protected from being overpressured by the following:

- 5.5.1 Relief valve(s) of adequate capacity set to relieve at 5% above the test pressure shall be installed unless the test pressure is less than 85% SMYS at which time it can be set at 10% above the test pressure. Sizing of these relief valves used for testing shall follow the requirements of API RP 520, Part 1. The relief valve(s) shall be tested, dated, and tagged within one week prior to the pressure test for new construction projects, and within one month for maintenance operations.
- 5.5.2 In addition to the pressure relieving device, a bleed valve shall be provided to protect the piping and equipment from overpressure. The bleed valve shall be readily accessible in case immediate depressurization is required.
- 5.5.3 An isolation valve shall be provided between the pressure testing manifold and the system being tested. The isolation valve shall be rated for the manifold test pressure when in the closed position.
- 5.5.4 Before employing the pressure testing manifold in the actual system pressure test, it shall be separately pressure tested to at least 1.2 times the system test pressure but not less than the discharge pressure of the pump used for the pressure testing.
- 5.6 Pressure Test Procedure
 - 5.6.1 A pressure test procedure shall be prepared by the responsible engineering group and made available to Inspection prior to conducting the test. The test procedure shall be available on site at all times.

The pressure test procedure shall include all required documentation specified in GI-0002.102, paragraph 5.2.

During a pneumatic pressure test a leak test shall be performed in accordance with ASME SEC V Article 10 and Article 10 Appendix I except the pressure shall be 5 – 10 psi instead of the design pressure. A calculation sheet indicating adequacy of the test Relief Valve shall be included in the procedure.

- 5.6.2 A request for NDT in lieu of pressure testing shall be submitted for approval as permitted in the specific SAES listed in Section 6 below. A sample form is provided in Appendix I. This form or an equivalent shall be processed prior to NDT.

Commentary Note:

The plant manager will sign the form for existing facilities and the Inspection Department Manager will sign for new construction projects.

- 5.7 The requirement for pre start-up leak tests and service tests during initial start-up and T&Is shall be as follows:

- 5.7.1 New systems after strength tests and prior to initial start-up:

5.7.1.1 For systems with maximum operating pressures greater than 6.894 MPa (1000 psi), a leak test with inert gas, followed by a service test, shall be conducted at the maximum operating pressure of the piping system. Oil flowlines, trunklines, testlines and water injection lines are excluded from this requirement.

5.7.1.2 For systems with maximum operating pressures less than 6.894 MPa (1000 psi), a pre start-up leak test with inert gas or steam (if designed for steam service) shall be conducted at the available inert gas or steam system pressure (not exceeding the maximum operating pressure), or pressure as recommended by responsible Operation Engineering Unit, followed by a service test at normal operating pressure of the piping systems. When inert gas or steam are not available, the service test will satisfy the pre start-up leak test requirements.

- 5.7.2 Existing systems after T&Is:

5.7.2.1 For systems with maximum operating pressures greater than 6.894 MPa (1000 psi) which are in hydrogen service or in sour service with hydrogen sulfide concentrations higher than 0.1 mole %:

5.7.2.1.1 A pre start-up leak test with inert gas shall be conducted after major T&Is. The test pressure shall be determined by the plant Operating Department. For minor T&Is, the pre start-up leak test shall be conducted per 5.7.2.2.

5.7.2.1.2 The pre start-up leak test shall be followed by a service test at the normal operating pressure of the piping.

Commentary Note:

A major T&I is defined as either a catalyst change or a major disassembly of flanges, gaskets, etc. The local Operation Engineering Unit and Inspection Unit have the responsibility to define when a T&I is considered as major. This definition must be made during the pre-T&I scope of work to allow Operations sufficient time to have inert gas on-site prior to start-up of the facility.

5.7.2.2 For all other systems and pressures, a pre start-up leak test with inert gas or steam (if designed for steam service) shall be conducted at the available inert gas or steam system pressure (not exceeding the maximum operating pressure), or at pressure as recommended by responsible Operation Engineering Unit, followed by a service test at normal operating pressure of the piping systems. When inert gas or steam are not available, the service test will satisfy the pre start-up leak test requirements.

5.7.2.3 Procedures for both pre start-up leak tests and service tests shall address, to the extent possible, the safety precautions provided in GI-0002.102 "Pressure Testing Safely".

5.8 If the drop in ambient temperature may cause the test medium to freeze during the test, appropriate precautionary measures must be taken to protect the equipment or piping systems.

6 Specific Testing Requirement

This section specifies in details which piping or equipment that shall be pressure tested and provides the specific applicable standard. It also defines any specific exemptions.

6.1 Plant Piping

Pressure testing of plant piping shall be in accordance with [SAES-L-150](#).

6.2 Cross-Country Pipelines

Pressure testing of cross country pipelines shall be in accordance of [SAES-L-150](#).

6.3 Pressure Vessels

6.3.1 Hydrostatic testing for new vessels (shop or field fabricated) shall be conducted as follows:

ASME Section VIII, D1 to SAMSS-004, Paragraph 16.3.8.1.

ASME Section VIII, D2 to SAMSS-004, Paragraph 16.3.8.2.

6.3.2 Hydrostatic testing for existing vessels shall be conducted per [SAES-D-008](#), Paragraph 10.1.

6.3.3 Pneumatic test, when approved (refer to paragraph 5.2), shall be conducted per UG-100 of ASME SEC VIII D1, or T-4 of ASME SEC VIII D2, whichever is applicable.

6.4 Heat Transfer Equipment

6.4.1 Hydrostatic tests for existing equipment shall be in accordance with [SAES-D-008](#).

6.4.2 For pneumatic testing, refer to paragraph 6.3.2.

6.4.3 Hydrostatic testing of new, field fabricated boilers shall be in accordance with [32-SAMSS-021](#). For pressure testing after repair or alteration, refer to [SAES-D-008](#) and National Board Inspection Code, NB-23. Hydrostatic test during T&Is shall be in accordance with the test pressure as specified on boiler's safety instruction sheet.

Hydrostatic test for new, field fabricated heater tube assembly shall be in accordance with [32-SAMSS-029](#).

6.4.4 Tube bundles which have been removed from the exchanger shell for maintenance purposes, shall be subjected to an in-situ shell side test per 6.4.1 prior to returning to service.

6.4.5 Fin fan exchangers shall be strength tested in-situ for the following cases:

6.4.5.1 Prior to final acceptance for all new projects, and

6.4.5.2 For maintenance purpose if exchanger has been transported.

6.5 Tanks

6.5.1 For new, field fabricated tanks, the hydrostatic testing shall be in accordance with [32-SAMSS-006](#) for large, low pressure welded tanks; or [32-SAMSS-005](#) for atmospheric steel tank.

6.5.2 For existing tanks, the hydrostatic testing shall be in accordance with [32-SAMSS-005/006](#) as applicable.

6.6 Fire Protection Systems

Pressure testing of new and existing fire protection systems shall be in accordance with [SAES-B-017](#) and GI-1781.001.

6.7 Refrigerant Piping Systems

Refrigerant piping serving building air conditioning systems shall be tested according to the requirements of [SAES-K-001](#) and the Uniform Mechanical Code (UMC), Section 1520.

6.8 Potable Water Systems

Potable water piping inside buildings shall be tested in accordance with the requirements of the Uniform Plumbing Code (UPC). Exceptions to UPC requirements are listed in [SAES-S-060](#).

Potable water piping outside of buildings shall be tested in accordance with the requirements of [SAES-S-040](#).

6.9 Utility Piping Systems

Utility piping systems, including irrigation piping and water distribution mains, shall be tested in accordance with [SAES-S-070](#).

6.10 Industrial Drainage and Sewers

Industrial drainage and sewers shall be tested in accordance with [SAES-S-020](#).

6.11 Sanitary Sewers

Sanitary sewer systems within buildings shall be tested per requirements of the Uniform Plumbing Code (UPC). Exceptions to UPC requirements are listed in [SAES-S-060](#).

Sanitary sewer lines outside of buildings shall be tested in accordance with [SAES-S-070](#).

6.12 Storm Water Drainage Systems

Storm water drainage systems shall be tested per [SAES-S-030](#).

6.13 Miscellaneous Building Services Piping

Steam and condensate piping outside the jurisdiction of ASME B31.3, heating and cooling water piping, vacuum and compressed air system piping for building services shall be tested per requirements of ASME B31.9, Building Services Piping.

6.14 Gas Cylinders

Gas cylinders shall be tested per Saudi Aramco Bottled Gas Manual.

6.15 Valves

Valves shall be tested in accordance with [SAES-L-108](#).

6.16 Non Metallic Piping

Non metallic piping such as RTR, Thermoplastic, PVC/UPVC and CPVC shall be tested in accordance [SAES-S-070](#).

7 Test Preparation

7.1 Site Preparation

7.1.1 An approved test procedure shall be available at the site prior to commencing any pressure testing activities.

7.1.2 New piping systems shall be cleaned in accordance with [SAES-L-350](#).

7.1.3 Soft seated valves and control valves shall not be installed until after the lines have been thoroughly flushed.

7.1.4 Components in new piping systems which interfere with filling, venting, draining or flushing shall not be installed until after line flushing and pressure testing are completed. These include orifice plates, flow nozzles, sight glasses, venturies, positive displacement and turbine meters and other in-line equipment.

7.1.5 Pressure gauges and pressure recorders shall be calibrated before the tests.

- a) The calibration interval shall not exceed one (1) month.
Calibration certificates shall be made available to Inspection
-

personnel prior to commencement of the pressure test. Stickers shall be applied indicating the latest calibration date.

- b) All gauges shall have a range such that the test pressure is within 30 to 80% of the full range.
- c) A minimum of two pressure gauges are required for the test system. One pressure gage shall be on the test manifold and the other(s) on the test system. Their accuracy shall be within 5% of one another.
- d) When large systems are tested, Inspection personnel will determine the need for additional gauges.
- e) Recording gauges shall be used where it is necessary to keep a permanent record, e.g., when the test duration exceeds four hours, or otherwise as required by this standard.

7.1.6 Expansion joints and spring hangers or spring supports shall be provided with temporary restraints where needed to prevent excessive travel or deformation under the test loads.

7.2 Equipment Excluded from Pressure Test

The following list defines the equipment that shall be excluded from the in-situ pressure testing of the tested system. Also, other unlisted sensitive equipment or as designated by Saudi Aramco Inspector can be added:

- a) Rotating machinery, such as pumps, turbines and compressors;
- b) Strainers and filter elements;
- c) Pressure relieving devices, such as rupture disks and pressure relief valves;
- d) Locally mounted indicating pressure gauges, where the test pressure will exceed their scale range;
- e) Equipment that cannot be drained;
- f) Instrument Devices.

7.3 Isolation of Test Sections

Paddle blinds or spectacle blinds shall be used to isolate the test sections. They shall be the same class rating of the system or may be fabricated based on appropriate calculations. When this is not practical, closed block valves (gate, globe, plug, ball) may be used to isolate equipment or piping sections (provided the valves are not passing, otherwise the spectacle plate/blind shall be installed in the closed position). If closed block valves are used in lieu of blinds,

provisions shall be made to ensure no overpressure can occur in the system that is not being tested, due to possible leak through the valves.

When a block valve is used for isolating test sections, the differential pressure across the valve seat shall not exceed the seat test pressure during pressure testing and shall not exceed the rated seat pressure during tightness test. Both sides of this valve shall be protected by relief valves during the test.

7.4 Vents and Drains

7.4.1 Vents shall be provided at all high points in the tested system as needed.

7.4.2 Excluding scrapable, submarine and buried pipelines, drains shall be provided at all low points in the system and immediately above check valves in vertical lines.

7.4.3 Unless the check valve has a by-pass valve, the disc of the check valve shall be removed, and securely attached to the outside of the check valve prior to the pressure test.

7.5 Temporary Connections and Supports

7.5.1 Temporary connections shall be provided for de-pressurizing and draining of the system to the sewer or disposal area.

7.5.2 Temporary supports shall be installed prior to hydrostatic testing, and flushing of the piping if they were determined to be required per [SAES-L-150](#). These supports shall not be removed until after the system has been fully drained. The structural support system for stacked equipment shall be verified for hydrostatic loads prior to testing.

8 Test Procedures

8.1 The test procedures shall be conducted in accordance with the applicable code. In addition, the following requirements shall apply.

8.1.1 Filling and pressurizing shall be done on the upstream side of check valves in the system. The test fluid shall be injected at the lowest point in the system to minimize entrapped air. When filling at the lowest point is not practical, the Inspection Department/ Operations Inspection Engineering Unit shall be consulted. All vents shall be open during filling.

8.1.2 After the test pressure is reached and before commencement of inspection of the system, the isolation valve between the temporary test manifold/piping and the piping/equipment under pressure test shall be

closed and the test pump disconnected. The isolation valve downstream of the manifold shall be opened after the pump is disconnected.

8.1.3 During the application of the test pressure, all in-line valves if not used as test isolation valves shall be in an open position.

8.2 All piping and equipment shall comply with the lay-up procedures per [SAES-A-007](#).

8.3 Test Records shall be recorded on Pressure Test Report Form 2642-ENG and the applicable "Safety Instruction Sheet" per [SAES-A-005](#).

9 After Completion of Pressure Test

After pressure testing has been successfully completed and approved by the Owner's Inspector, the following operations shall be made.

9.1 Draining of Test Fluid

Release of pressure and draining shall be done on the downstream side of check valves. All vents shall be opened before draining to facilitate drainage and to prevent formation of a vacuum. No test fluid shall remain in low spots.

9.2 Disposal of Test Fluid

The test fluid shall be disposed in accordance with [SAEP-327](#) or as directed by the Owner.

9.3 Test Vents and Drains

Vents and drains used only for the pressure test shall be plugged, seal welded and penetrant tested.

9.4 Removal and Reconnection of Components

All temporary items installed for testing purposes (e.g., manifolds, valves, blinds, spacers, supports) shall be removed.

Items that were removed from testing shall be reinstalled.

Items, such as instrument air tubing, check valve discs which were disconnected before testing shall be reconnected.

Isolation valves closed for the test purposes and that are required to be in the open position for process reasons shall be opened. If the valve cavity has a drain, the cavity shall be drained.

30 March 2005

Revision Summary
Major revision.

Appendix I – Sample Form of Request for Non-Destructive Testing In-Lieu of Hydrostatic Test

RT MT or PT

BI/JOWO: _____ DATE: _____

ORIGINATOR: _____ LOCATION: _____
TITLE _____

ORGANIZATION: _____ ADDRESS _____ PHONE _____

=====

PRESENT SITUATION: _____

JUSTIFICATION: _____

INSPECTION COMMENTS: _____

CONDITIONS OF APPROVAL: _____

REASONS FOR DISAPPROVAL: _____

CONCUR: _____
RESPONSIBLE ENGRG. GROUP

APPROVED BY^(Note 3): _____, or
PLANT MANAGER

MANAGER, INSPECTION DEPARTMENT

NOTES:

1. Attach sketch or drawing showing location of welds to be radiographed.
2. Design information such as wall thickness, material, service conditions, operating pressure and temperature shall also be included.
3. The plant manager will sign the form for existing facilities and the Inspection Department Manager will sign for new construction projects.

Appendix II – Sample of SA 2642-ENG Pressure Test Report Form

SAUDI ARAMCO PRESSURE TEST REPORT

SAUDI ARAMCO 2642-ENG (03/05)

Reference Details:

Plant Name: _____ Plant No.: _____ BI No.: _____ Project Name: _____

Responsible Inspection Unit: _____ Equipment Description: _____ Location of Test: _____

System No.: _____ Purchase/Work Order No.: _____ Letter/Diagram No.: _____

Verbal Report To: Name: _____ Position: _____ Badge No.: _____ Date: ____/____/____

Test Details: Initial Test Revalidation Test Type: Hydrostatic Test Pneumatic Test Pre Start-up Leak Test

Test Procedure No.: _____ In Accordance with: _____ MAOP: _____ PSIG MDMT: _____ °F Test Fluid Type: _____

Test Fluid Quality: pH: ____ SRB: ____ Oxygen Scavenger: ____ Test Pressure: _____ Test Temperature: ____ °F Test Duration: ____

Relief Valve Test Date: ____/____/____ Relief Valve Set Pressure: _____ PSIG Relief Valve Tag No.: _____

No. of Pressure Gauges: ____ Pressure Gauge Calibration Date: ____/____/____ Pressure Gauge Range: 0 to _____ PSIG

Flushing/Cleaning: Method Used: _____ Accepted: Rejected:

Inspectors Name: _____ Signature: _____ Badge No.: _____ Date: ____/____/____

Lay-Up Procedure: None: Ambient Lay-Up: Wet Lay-Up: Dry Lay-Up: Other Method: _____

Sketch:

Pressure Test Results: Accepted: Rejected:

Inspectors Name: _____ Signature: _____ Badge No.: _____ Date: ____/____/____

Field Supervisor Name: _____ Signature: _____ Badge No.: _____ Date: ____/____/____

Comments:

