

# Engineering Standard

19 April 2022

## **SAES-A-004** **General Requirements for Pressure Testing**

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Document Responsibility: Project Quality Standards Committee

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## Summary of Changes

| Paragraph Number  |                  | Change Type<br>(Addition, Modification, Deletion, New) | Technical Change(s)  |
|-------------------|------------------|--|--|
| Previous Revision | Current Revision |  |  |
|                   |                  |  |  |
| 1.1               | 1.1              | Modification   | Deleted the word "General" for better clarify  |
| 1.4               | 1.4              | Modification   | Deleted the word "Normally" for better clarify.<br>Deleted statement "Responsibilities for pre-start-up leak tests are defined in this standard" since it is already covered at Para 8.3 & 8.4<br>Pre-start-up "pressure" test is modified to pre-start-up "leak" test |
| 1.5.1             | 1.5.1            | Modification   | Deleted "of the test system" for better clarify  |
| 1.5.1.5           | -                | Deletion   | Deleted, since equipment cannot be drained can be pneumatically tested   |
| 3                 | 3                | Modification   | The statement modified to align with the standard format for the SAES  |
| 3.1               | 3.1              | Addition   | The following standards are added to the references: SAEP-43, SAEP-1140, SAEP-1142, SAES-L-450, SAES-L-650 01-SAMSS-044, ASME PCC-2, API STD 620, API STD 650, API STD 653   |
| 3.1               | 3.1              | Deletion   | The following standards are deleted from the references: SAEP-381, SAEP-1132, SAEP 351, ASME-B31.5, Uniform Mechanical Code (UMC), API STD 510, API STD 570  |
| 4.2               | 4.1              | New/ Modification                                      | Added acronym for CRA and Modified for SAIF and T&I  |
| 4.1               | 4.2              | New  | Introduced the definition of Dummy Spool   |
| 4.1               | 4.2              | Modification   | The design of the manifold shall be in accordance with the applicable construction code.   |

| Paragraph Number  |                  | Change Type<br>(Addition, Modification, Deletion, New) | Technical Change(s)   |
|-------------------|------------------|--|---|
| Previous Revision | Current Revision |  |   |
|                   |                  |  |   |
| 4.1               | 4.2              | Modification   | The definition of the Minimum Design Metal Temperature (MDMT) is modified to align with the International Standard.                           |
| 4.1               | 4.2              | Modification   | Clarified and Organized the definitions of the different type of Pressure Tests   |
| 5.2, 5.3          | 5.2, 5.3         | Modification   | Reorganized the paragraph for better clarity  |
| 5.4.2             | 5.4.2            | Modification   | Reorganized the paragraph for better clarity<br><br>Specified the organizations responsible for the approval for Pneumatic Test               |
| 5.7.3             | 5.7.3/5.7.4      | modification   | Split the paragraphs for better clarity   |
| 5.8.3             | 5.8.3            | Modification   | Preliminary leak test prior to pneumatic test is clarified (editorial change), the test pressure unit standardized to SI units.               |
| 5.9               | 8                | Modification   | The pre-start-up leak test requirements are re-organized to para 8  |
| 5.12.1            | 5.11.1           | Addition   | For the new projects, SAEP1160 to be followed for the content of the hydro test package.  |
| 5.12.3            | 5.11.3           | Modification   | Notes added to clarify the case of Welded type soft seated valve requirements   |
| 5.12.6.3          | 5.11.6.3         | Modification   | Unit for the Pressure gauge range standardized to SI units (editorial change)   |
| 5.15.1            | 5.14.1, 5.14.2   | Modification/<br>Addition                              | The requirements for the temporary connections including dummy spools are clarified. The testing requirements for the dummy spools are added. |
| 6.1               | 6.1              | Modification   | Editorial change from test procedure to Pressure test.  |
| 5.9               | 8                | Modification   | Pre-start-up leak test requirements are clarified   |

| Paragraph Number               |                                | Change Type<br>(Addition, Modification, Deletion, New) | Technical Change(s)   |
|--------------------------------|--------------------------------|--|---|
| Previous Revision              | Current Revision               |  |   |
| (24 October 2018)              | (01 March 2022)                |  |   |
| Appendix A                     | Appendix A                     | Modification   | Editorial changes to the title statement, from Test Procedure to pneumatic test package.<br><br>Updated the references.   |
| Appendix A<br>Item 28, 29 & 30 | Appendix A<br>Item 28, 29 & 30 | Modification   | Editorial change - ASME PCC-2-2008, Article 5.1 is replaced by ASME PCC-2, Article 501 to align the International Standard.   |
| Appendix B                     | Appendix B                     | Addition   | The requirements for the thickness verification are added for the revalidated manifolds.  |
| Appendix B                     | Appendix B                     | Modification   | The seal welding of thread connections on the hydro test manifold and the Leak testing requirements are clarified   |
| Appendix C<br>Item 1           | Appendix C<br>Item 1           | Modification   | Note added to ensure the thickness verification through proper NDT is performed prior to approval   |
| Appendix C<br>Item 7           | Appendix C<br>Item 7           | Modification   | Clarified that, Saudi Aramco Inspector to witness the pressure test of the Manifold prior to approval.  |
| Appendix D                     | Appendix D                     | Add  | Note added to recommend to evaluate the usage of this appendix at the planning stage prior to fabrication.  |
| Appendix F<br>Item 9           | Appendix F<br>Item 9           | Modification   | Clarified the applicability for only non-metallic Utility Piping  |
| --                             | Appendix F<br>Item 18, 19      | New  | Applicable standard for the hydro test for CRA Clad Pipe Spools and Laterals and included.  |
| Appendix H                     | Appendix H                     | Modification   | Additional options for the NDT are introduced for NDT in Lieu of Hydro test conditions in case of the limitation to perform PAUT due to geometry restrictions, attachments etc. |
| 6.1                            | 6.1                            | Modification   | Updated the organization to be consulted, due to change in the unit name  |

## 1. Scope

- 1.1 This standard defines mandatory requirements governing pressure testing of new and existing metallic and non-metallic 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.
- 1.2 This standard supplements ASME B31.1, ASME B31.3, ASME B31.4, ASME B31.8, and other applicable codes.
- 1.3 This standard applies to:
  - 1.3.1 Field and shop fabricated piping systems
  - 1.3.2 Field fabricated equipment
- 1.4 This standard applies to pre-start-up leak tests conducted during start-up, commissioning and T&I of facilities in accordance with approved operating procedures.
- 1.5 Exclusions:

### 1.5.1 Equipment Excluded from Pressure Test

The following list defines the equipment that shall be excluded from the pressure testing. Also, other unlisted sensitive equipment or as designated by Saudi Aramco Piping Standards Committee or other equipment specific Saudi Aramco Standards Committees can be added:

- 1.5.1.1 Rotating machinery, such as pumps, turbines, and compressors;
- 1.5.1.2 Filter elements;
- 1.5.1.3 Pressure relieving devices, such as rupture disks and pressure relief valves;
- 1.5.1.4 Locally mounted indicating pressure gauges, where the test pressure will exceed their scale range;
- 1.5.2 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.

## 2. Conflicts and Deviations

Any conflicts between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed to the EK&RD Coordinator.

Any deviation from the requirements herein shall follow internal company procedure SAEP-302.

## 3. References

All referenced specifications, standards, codes, drawings, and similar material are considered part of this engineering standard to the extent specified, applying the latest version, unless otherwise stated.

### 3.1. Saudi Aramco References

Saudi Aramco Engineering Procedures

|                                  |  |
|----------------------------------|--|
| <a href="#"><u>SAEP-35</u></a>   | Valves Handling, Hauling, Receipt Tests and Storage                                  |
| <a href="#"><u>SAEP-43</u></a>   | Lay-up and Preservation Methods  |
| <a href="#"><u>SAEP-302</u></a>  | Waiver of a Mandatory Saudi Aramco Engineering Requirement                           |
| <a href="#"><u>SAEP-317</u></a>  | Testing and Inspection (T&I) of Shell and Tube Heat Exchangers                       |
| <a href="#"><u>SAEP-319</u></a>  | Pressure Relief Devices - Testing and Inspection Requirements                        |
| <a href="#"><u>SAEP-324</u></a>  | Certification Review and Registration of Project Welders                             |
| <a href="#"><u>SAEP-327</u></a>  | Disposal of Wastewater from Cleaning, Flushing, and Dewatering Pipelines and Vessels |
| <a href="#"><u>SAEP-384</u></a>  | In-service Inspection Requirements for RTR Pipe                                      |
| <a href="#"><u>SAEP-385</u></a>  | Preservation of Project Materials and Equipment                                      |
| <a href="#"><u>SAEP-1140</u></a> | Qualification and Certification of Saudi Aramco NDT Personnel                        |
| <a href="#"><u>SAEP-1142</u></a> | Qualification of non-Saudi Aramco NDT Personnel                                      |
| <a href="#"><u>SAEP-1160</u></a> | Tracking and Reporting of Welding, NDT, and Pressure Testing for Capital Projects    |

Saudi Aramco Engineering Standards

|                                   |                          |
|-----------------------------------|--------------------------|
| <a href="#"><u>SAES-A-005</u></a> | Safety Instruction Sheet |
|-----------------------------------|--------------------------|

|                                   |   |
|-----------------------------------|---|
| <a href="#"><u>SAES-A-007</u></a> | Hydrostatic Testing Fluids and Lay-up Procedures  |
| <a href="#"><u>SAES-B-017</u></a> | Fire Water Systems  |
| <a href="#"><u>SAES-D-008</u></a> | Repairs, Alteration, and Re-rating of Process Equipment   |
| <a href="#"><u>SAES-D-108</u></a> | Repair, Alteration, and Reconstruction of Storage Tank  |
| <a href="#"><u>SAES-H-001</u></a> | Coating Selection and Application Requirements for Industrial Plants and Equipment                      |
| <a href="#"><u>SAES-J-901</u></a> | Instrument Air Supply Systems   |
| <a href="#"><u>SAES-K-001</u></a> | Heating, Ventilating, and Air-Conditioning  |
| <a href="#"><u>SAES-K-100</u></a> | Saudi Aramco Mechanical (HVAC) Code   |
| <a href="#"><u>SAES-L-108</u></a> | Selection of Valves   |
| <a href="#"><u>SAES-L-109</u></a> | Selection of flanges, Stud Bolts and Gaskets  |
| <a href="#"><u>SAES-L-125</u></a> | Safety Instruction Sheet for Piping and Pipelines   |
| <a href="#"><u>SAES-L-150</u></a> | Pressure Testing of Plant Piping and Pipelines  |
| <a href="#"><u>SAES-L-350</u></a> | Construction of Plant Piping  |
| <a href="#"><u>SAES-L-450</u></a> | Construction of on-Land and Nearshore Pipelines   |
| <a href="#"><u>SAES-L-650</u></a> | Construction of Reinforced Thermosetting Resins (RTR) Piping in Hydrocarbon and Water Injection Systems |
| <a href="#"><u>SAES-S-020</u></a> | Oily Water Drainage Systems   |
| <a href="#"><u>SAES-S-040</u></a> | Saudi Aramco Water Systems  |
| <a href="#"><u>SAES-S-060</u></a> | Saudi Aramco Plumbing Code  |
| <a href="#"><u>SAES-S-070</u></a> | Installation of Utility Piping Systems  |
| <a href="#"><u>SAES-W-012</u></a> | Welding Requirements for Pipelines  |

#### Saudi Aramco Materials System Specifications

|                                     |   |
|-------------------------------------|---|
| <a href="#"><u>01-SAMSS-010</u></a> | Fabricated Carbon Steel Piping            |
| <a href="#"><u>04-SAMSS-048</u></a> | Valve Testing and Inspection Requirements |
| <a href="#"><u>32-SAMSS-004</u></a> | Manufacturing of Pressure Vessels         |
| <a href="#"><u>32-SAMSS-005</u></a> | Manufacturing of Atmospheric Tanks        |
| <a href="#"><u>32-SAMSS-006</u></a> | Manufacturing of Low-Pressure Tanks       |
| <a href="#"><u>32-SAMSS-011</u></a> | Manufacture of Air-Cooled Heat Exchangers |
| <a href="#"><u>32-SAMSS-029</u></a> | Manufacturing of Fired Heaters            |
| <a href="#"><u>32-SAMSS-036</u></a> | Manufacture of Small Pressure Vessels     |

|                                     |  |
|-------------------------------------|--|
| <a href="#"><u>01-SAMSS-044</u></a> | CRA Clad Pipe Spools   |
| Saudi Aramco Form and Data Sheet    |  |
| <a href="#"><u>SA-2642</u></a>      | Pressure Test Report Form  |
| Saudi Aramco General Instructions   |  |
| <a href="#"><u>GI-0002.102</u></a>  | Pressure Testing Safely  |
| <a href="#"><u>GI-1781.001</u></a>  | Inspection, Testing and Maintenance of Fire Protection Equipment |

### **3.2. Industry Codes and Standards**

American Petroleum Institute

|             |  |
|-------------|--|
| API RP 520  | Part I - Sizing, Selection, and Installation of Pressure Relieving Devices |
| API STD 598 | Valve Inspection and Testing   |
| API STD 620 | Design and Construction of Low-Pressure Storage Tank                       |
| API STD 650 | Welded Tank for Oil Storage  |
| API STD 653 | Tank Inspection, Repair, Alteration and Reconstruction                     |

American Society of Heating, Refrigerating and Air Conditioning Engineers

|               |   |
|---------------|---|
| ASHRAE Std 15 | Safety Standard for Refrigeration Systems             |
| ASHRAE Std 34 | Designation and Safety Classification of Refrigerants |

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 B31.8       | Gas Transmission and Distribution Piping Systems                          |
| ASME B31.9       | Building Services Piping  |
| ASME SEC I       | Rules for Construction of Power Boilers                                   |
| ASME SEC V       | Article 10 Leak Testing   |
| ASME SEC VIII D1 | Boiler and Pressure Vessel Code   |
| ASME SEC VIII D2 | Alternative Rules   |
| ASME PCC-2       | Repair of Pressure Equipment and Piping                                   |

National Board of Boiler and Pressure Vessel Inspectors

NBIC National Board of Inspection Code

## Uniform Plumbing Code (UPC)

## 4. Terminology

#### 4.1. Acronyms

|             |                                       |
|-------------|---------------------------------------|
| <b>AUT</b>  | Automatic Ultrasonic Testing          |
| <b>CDTP</b> | Cold Differential Test Pressure       |
| <b>CRA</b>  | Corrosion Resistant Alloy             |
| <b>CRM</b>  | Customer Relation Management          |
| <b>CSD</b>  | Consulting Services Department        |
| <b>IEU</b>  | Inspection Engineering Unit           |
| <b>GI</b>   | General Instruction                   |
| <b>MAWP</b> | Maximum Allowable Working Pressure    |
| <b>MDMT</b> | Minimum Design Metal Temperature      |
| <b>MT</b>   | Magnetic-Particle's Technique         |
| <b>MUT</b>  | Manual Ultrasonic Testing             |
| <b>NDT</b>  | Non-Destructive Testing               |
| <b>PAUT</b> | Phased Array Ultrasonic Testing       |
| <b>PIEU</b> | Project Inspection Engineering Unit   |
| <b>PQM</b>  | Project Quality Manager               |
| <b>PT</b>   | Liquid-Penetrant Testing              |
| <b>RT</b>   | Radiographic Testing                  |
| <b>RTFI</b> | Radiographic Test Film Interpretation |
| <b>RTR</b>  | Reinforced Thermosetting Resin        |
| <b>SAEP</b> | Saudi Aramco Engineering Procedure    |

|                |   |
|----------------|---|
| <b>SAES</b>    | Saudi Aramco Engineering Standard             |
| <b>SAIF</b>    | System Assurance and Inspection of Facilities |
| <b>SAMSS</b>   | Saudi Aramco Materials System Specification   |
| <b>SAPMT</b>   | Saudi Aramco Project Management Team          |
| <b>SRB</b>     | Sulfate Reducing Bacteria                     |
| <b>SMYS</b>    | Specified Minimum Yield Strength              |
| <b>T&amp;I</b> | Turnaround and Inspection                     |
| <b>UT</b>      | Ultrasonic Testing                            |

#### 4.2. Definitions

**Alteration:** A physical change in any component that has design implications affecting the pressure containing capability or flexibility of a piping system beyond the scope of its original design. The following are not considered alterations: comparable or duplicate replacements and the addition of small-bore attachments that do not require reinforcement or additional support.

**Applicable Code:** The code, code section, or other recognized and generally accepted engineering standard or practice to which the piping system was built or which is deemed by the company or user or the piping engineer to be most appropriate for the situation.

**Category D Fluid Service:** As defined in ASME B31.3 for all fluids utilized in Category D piping systems.

**Design Pressure:** The pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service.

**Dummy Spool:** A dummy spool, is a piece of pipe, with one flange at each end, to replace a inline equipment like valve, venturis etc. during hydro test

**Major T&I:** A major T&I is defined as either a catalyst change or a major disassembly of flanges, gaskets, etc. The Facility Operations Engineering Unit and Operations 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.

**Manifold:** is a pipe or chamber branching into several openings which shall be designed according to applicable code. During hydro test, one opening of

manifolds connected to pressurizing pump through an isolation valve and non-return valve and other opening to the piping system/pipeline through an isolation valve.

**Maximum Allowable Working Pressure (MAWP):** The maximum internal pressure permitted in the piping system for continued operation at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service. It is the same as the design pressure, as defined in ASME B31.3 and other code sections, and is subject to the same rules relating to allowances for variations of pressure or temperature or both.

**Maximum Operating Pressure:** The maximum pressure expected during normal system operation.

**Minimum Design Metal Temperature (MDMT):** The lowest permissible metal temperature for a given material at a specified thickness based on its resistance to brittle fracture.

**Non-destructive Testing:** Testing method, such as radiography, ultrasonic, magnetic testing, liquid penetrant, visual, leak testing, eddy current, and acoustic emission, or a testing technique, such as magnetic flux leakage, magnetic particle inspection, shear-wave ultrasonic, and contact compression-wave ultrasonic.

**Operating Pressure:** The pressure at which the equipment normally operates. It shall not exceed the maximum allowable working pressure, and it is usually kept at a suitable level below the setting of the pressure relieving devices to prevent their frequent opening.

**Plant Piping:** Piping that is inside the boundary limits of the plant and is generally, but not necessarily, designed to ASME B31.3 code except in area(s) set aside for piping within other code or government regulations.

**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. Pressure test may be a:

- **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.

*Note:*

*The strength test is the term used by ASME B31.8 code. It is the same as the hydrostatic leak test used in ASME B31.3 or the proof test in ASME B31.4.*

- **Hydrostatic Test:** A pressure test conducted using water or other proper test medium as mentioned in GI-0002.102 paragraph 5.1.3.
- **Pneumatic Test:** A pressure test conducted using air or other noble gases as mentioned in GI-0002.102 paragraph 5.1.3 or in conjunction with liquid.
- **Tightness Test:** A pressure test to ensure tightness of the piping system (i.e., no leaks in the system) at the test pressure, normally it is 95% of the strength test.
- **Service Test:** A pressure test performed to prove the integrity of pipelines or plant piping using the service fluid at maximum attainable operating pressure.
- **Leak Test:** A pressure test to ensure tightness of flanged and threaded joints at the test pressure. It is conducted before initial start-up, during commissioning or after T&Is. This leak test is different from tightness test specified above.
- **Revalidation Test:** A pressure test performed to prove the integrity of existing piping or equipment. This test is administered by the proponent organization.

**Pressure Test Procedure:** A document detailing what to test and how to conduct the test, the acceptance criteria, and the safety requirements to conform with [GI-0002.102](#) and the applicable Saudi Aramco Standards and Industrial Standards.

**Proponent Organization:** Any organization that has been assigned ownership by the Company to occupy and/or operate in any onshore/offshore community or plant (industrial and non-industrial) facility or marine vessels or building.

**Repair:** The work necessary to restore a piping system or process equipment to a condition suitable for safe operation at the design conditions. If any of the restorative changes result in a change of design temperature or pressure, the requirements for re-rating also shall be satisfied. Any welding, cutting, or grinding operation on a pressure-containing piping component not specifically considered an alteration is considered a repair.

**Senior Operations' Representative:** The Lead or most senior operation representative on a new construction project or may be a Facility/Plant Manager if one has been appointed.

**T&I (Turnaround & Inspection):** A time-based activity scheduled by a plant's Inspection Unit through an approved Equipment Inspection Schedule (EIS).

**Welding Procedure Specification (WPS):** A written qualified welding procedure prepared to provide direction for making production welds to Code requirements. The WPS or other documents may be used to provide direction to the welder or welding operator to ensure compliance with the Code requirements.

## 5. Pre-Pressure Test Requirements

- 5.1 General Instruction [GI-0002.102](#) "Pressure Testing Safely" shall be followed during pressure testing. Supplement 1- "Checklist for Pressure Testing Safely" shall be completed and complied with.
- 5.2 Testing fluid quality shall be as per [SAES-A-007](#) "Hydrostatic Testing Fluids and Lay-up Requirements".
- 5.3 The test fluid shall be water unless there is possibility of damage to the piping system or the process due to freezing or other adverse effects or the test water will become contaminated and its disposal will present environmental problems.

## 5.4 Pneumatic Testing

- 5.4.1 "Checklist for Pneumatic Test" in [Appendix A](#) need to be filled and submitted together with all supporting documents for the approval.
- 5.4.2 Pneumatic strength testing is not permitted without approval from below entities, unless it is allowed by this standard or the referenced Saudi Aramco SAESs. The approval shall be through CRM.
  - a) Inspection Department/Inspection Engineering Unit (ID/ITSD/IEU) Supervisor for operating facilities.
  - b) Inspection Department/Project Inspection Engineering Unit (ID/ITSD/PIEU) Supervisor for projects.
- 5.4.3 Preliminary pneumatic test using air at no more than 170 kPa (25 psi) gauge pressure which may be made prior to hydrostatic testing to locate major leaks according to [ASME B31.3](#) paragraph 345.2.1 without written approval as required in 5.4.1 and 5.4.2.

- 5.5 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.
- 5.6 Test pressures and test durations shall be based on the applicable Saudi Aramco standards as specified in [Appendix F](#) and other design conditions.

## 5.7 Protection from Overpressure

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

- 5.7.1 Pressure test 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 two weeks prior to the pressure test for new construction projects, and within three months for maintenance operations.

The pressure test relief valve shall be accompanied with a calibration certificate that includes the cold differential test pressure (CDTP), test date and the spring range. The CDTP shall be within the spring range.

Pressure testing relief valves shall be car sealed at the pressure adjusting screw and verified prior to test.

- 5.7.2 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.
- 5.7.3 An isolation Valve and the Check valve shall be provided between manifold and the pressurization pump.
- 5.7.4 An isolation valve shall be provided between the pressure testing manifold and the system being tested. The isolation valves shall be rated for the manifold test pressure when in the closed position.
- 5.7.5 Testing manifold shall be approved for use and maintained as per the requirements in [Appendix B](#). Manifold approval form is available in [Appendix C](#).

## 5.8 Pressure Test Procedure

- 5.8.1 A pressure test procedure shall be prepared by the responsible engineering group and made available to responsible inspection group prior to conducting the test. The test procedure shall be available on site at all times.

*Note:*

*The responsible engineering group for operating facilities is Technical Support Unit / Specialist Engineering, if none exist, then it is Operations/Process Engineering. For new projects, it is the contractor's responsibility.*

- 5.8.2 The pressure test procedure shall include all required documentation specified in [GI-0002.102](#), paragraph 5.1.2.5.

- 5.8.3 Prior to pneumatic pressure test a leak test shall be performed in accordance with [ASME SEC V](#) Article 10, Mandatory Appendix I at 35-69 KPa (5–10 psi) pressure. A calculation sheet indicating adequacy of the pressure test relief valve shall be included in the test package.
- 5.9 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.
- 5.10 All joints (including structural attachment welds to pressure-containing components) shall be left uninsulated and exposed for examination during piping hydrostatic testing. Hydrostatic testing with primed and painted joints in piping systems may be done if conditions in [Appendix D](#) are met.

## 5.11 Site Preparation

- 5.11.1 An approved test procedure and approved test package shall be available at the site prior to commencing any pressure testing activities. For new project, the hydro test package shall be in accordance with [SAEP-1160](#).
- 5.11.2 New piping/pipeline systems shall be cleaned in accordance with [SAES-L-350](#) and [SAES-L-450](#).
- 5.11.3 Soft seated valves and control valves shall not be installed until the lines have been thoroughly flushed in accordance with [SAES-L-350](#) Paragraph 14.

*Note:*

*CSD Piping Standards Committee and Valves Standards Committee shall be consulted prior to select any soft seated welded valves in the piping/pipeline design.*

- 5.11.4 Components in new piping systems which interfere with filling, venting, draining or flushing should not be installed until line flushing and pressure testing are completed. These include orifice plates, flow nozzles, sight glasses, venturis, positive displacement and turbine meters, and other in-line equipment.
- 5.11.5 In case instruments are installed and it is not practical to remove them, conditions in-lieu of instruments removal prior to pressure testing in [Appendix E](#) shall be followed.
- 5.11.6 Pressure gauges, pressure, and temperature recorders.
- 5.11.6.1 All gauges and recorders shall be calibrated prior to use.

- 5.11.6.2 The calibration interval shall not exceed thirty (30) days prior to the test date and 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.
  - 5.11.6.3 All gauges shall have a range such that the test pressure is within 30 to 80% of the full range (i.e., a gauge with a 0 to 1750 KPa (250 psi) range is suitable for test pressures 525 till 1400 KPa (75 till 200 psi)).
  - 5.11.6.4 A minimum of two pressure gauges are required for the test system. One pressure gauge shall be on the test manifold and the other on the highest elevation point of the system to be tested. Their accuracy shall be within 5% of one another. The test pressure shall be achieved at the lowest point in the system.
  - 5.11.6.5 When large systems are tested, Inspection personnel will determine the need for additional gauges.
  - 5.11.6.6 Pressure and temperature recording gauges shall be used for all buried piping systems on plot and per [SAES-L-150](#) for pipelines.
  - 5.11.6.7 If the pressure decreases more than 5%, the piping should be visually inspected to find the leak.
- 5.11.7 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.

## 5.12 Isolation of Test Sections

- 5.12.1 Blind flanges, 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 from verifiable and identifiable base material and calculations shall be according to the same ANSI/ASME code of the system. When this is not practical, closed block valves (gate, globe, plug, and 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.
- 5.12.2 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.

### **5.13 Vents and Drains**

- 5.13.1 Vents shall be provided at all high points in the tested system as needed. Cross-country or submarine pipelines may be exempted if a scraper will be used ahead of the test water to purge air from the lines before the test pressure is applied.
- 5.13.2 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.
- 5.13.3 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. The disc of the check valve may not be removed if pressurization is upstream of the check valve and depressurization in the downstream side.

### **5.14 Temporary Connections and Supports**

- 5.14.1 All Temporary connections (manifolds, valves, test drain & vent, blinds, spacers etc.) and dummy spools shall be of same or higher-pressure rating as the piping system. All the welds shall have 100% NDT, pre-hydrotested and approved as per [Appendix C](#) prior to use.
- 5.14.2 Temporary hose connections for de-pressurizing and draining of the system to the sewer or disposal area shall be of same or higher rating.
- 5.14.3 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.

### **5.15 Utilizing Non-destructive Testing (NDT) in Lieu of Pressure Testing for Metallic Piping and Pipelines**

- 5.15.1 Where both hydrostatic and pneumatic leak testing impracticable, NDT in-lieu of pressure testing may be used if both of the following conditions apply:
  - 5.15.1.1 A hydrostatic test would:

- a) Damage linings or internal insulation
- b) Contaminate a process that would be hazardous, corrosive, or inoperative in the presence of moisture
- c) Require significant support modifications for the hydrostatic test load
- d) Present the danger of brittle fracture due to low metal temperature during the test

5.15.1.2 A pneumatic test would:

- a) Present an undue hazard of possible release of energy stored in the system or
- b) Present the danger of brittle fracture due to low metal temperature during the test
- c) Unless specified in the engineering design, lines open to the atmosphere with a maximum internal pressure not exceeding 69 kPa (10 psig), such as vents or drains downstream of the last shutoff valve, need not be leak tested.

5.15.2 A request to utilize NDT in-lieu of pressure testing shall be submitted for approval. For existing operating facilities, the request shall be submitted through SAIF and conditions in [Appendix H](#) shall be followed. For facilities under construction, a sample request form is provided in [Appendix H](#).

## 6. During Pressure Test Requirements

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

6.1.1 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/ Inspection Engineering Unit shall be consulted. All vents shall be opened during filling.

The pressure rise during a pressure test shall be gradual and under control as specified in [GI-0002.102](#) paragraph 5.2.3.

6.1.2 No one shall approach the test area for a minimum of 10 minutes 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.

- 6.1.3 During the application of the test pressure, all in-line valves if not used as test isolation valves shall be in a fully open position.
  - 6.1.4 The pressure shall be gradually increased until a gauge pressure which is the lesser of one-half the test pressure or 170 kPa (25 psi) is attained, at which time a preliminary check shall be made, including examination of joints. Thereafter, the pressure shall be gradually increased in steps until the test pressure is reached, holding the pressure at each step long enough to equalize piping strains. The pressure shall then be reduced to the design pressure before examining for leakage.
- 6.2** Test records shall be recorded on Pressure Test Report SATR-A-2001 and the applicable "Safety Instruction Sheet" per [SAES-A-005](#) and [SAES-L-125](#) for projects and facilities under construction. For operating facilities, SAIF - Pressure Test Module shall be used instead of [SA-2642](#).
- 6.3** Retention of pressure testing records shall be a minimum of 5 years.

## **7 Post Pressure Test Requirements**

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

### **7.1 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 vacuum. No test fluid shall remain in low spots.

### **7.2 Disposal of Test Fluid**

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

### **7.3 Test Vents and Drains**

Vents and drains used only for the pressure test shall be plugged, seal welded and penetrant tested after removal of temporary block valves when applicable. Proponent agreement shall be obtained prior to removal of the block valves, seal welding of vents and drains due to operation and maintenance purposes.

## 7.4 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.

- 7.5** All piping, pipelines and equipment shall comply with the lay-up and preservation procedures per [SAES-A-007](#), [SAEP-43](#) and [SAEP-385](#).

## 8 Pre-Start-up Leak Test & Service Tests

Pre-start-up leak tests and service tests shall be performed during commissioning stage prior to initial start-up or after T&Is. The following requirements shall be followed:

- 8.1** New systems prior to initial start-up:

- 8.1.1 For systems with maximum operating pressures greater than 6.894 MPa (1,000 psi) or Hydrogen service, a leak test with inert gas, followed by a service test, shall be conducted at the maximum operating pressure of the piping system.

*Note:* *Liquid transportation Pipelines which are designed per ASME B31.4 and water injection system are excluded from the pre-start-up leak test with inert gas, however, service leak test using the process medium at normal operating pressure shall be performed during the start-up of the system.*

- 8.1.2 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 the facility Engineering Unit responsible for developing the test package, 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.

## 8.2 Existing Systems after T&Is

- 8.2.1 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 %:

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 8.2.2. The pre-start-up leak test shall be performed followed by a service test at the normal operating pressure of the piping/pipeline system.

- 8.2.2 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 Operations Engineering Unit followed by service test at normal operating pressure of the piping/pipeline systems. When inert gas or steam are not available, the service test will satisfy the pre-start-up leak test requirements.

*Note:*

*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.”*

- 8.3 For new project, Commissioning team including new construction contractor(s) shall have responsibility to conduct pre-start-up leak test witnessed by a Saudi Aramco operation representative.
- 8.4 Saudi Aramco Operations shall be responsible for pre-start-up leak test in existing facilities during T&I which do not include any new construction by a third party.

## Document History

- 19 April 2022 Editorial revision to change the contact person.
- 01 March 2022 Major revision to provided clarification to the pre-start-up leak test and included additional options for NDT in-lieu of hydrostatic test.
- 24 October 2018 Major revision to align with ASME B31.3 allowing pressure testing with full coated welds and provide clarification for NDT in-lieu of hydrostatic test.
- 29 August 2016 Editorial revision to transfer the document from Inspection Engineering to Project Quality Standards Committee.
- 7 January 2016 Major revision that will evaluate incorporating basis of recent waivers and alignment with the international standard ASME B31.3 to allow pressure testing with instruments and coated welds.

## Appendix A - Pneumatic Test Checklist

The information contained below shall be included or referenced in each pneumatic test package as a minimum:

| Item | Description  | Reference  | Check Box (✓) |                        |                  |                | Remarks |
|------|--|--|---------------|------------------------|------------------|----------------|---------|
|      |  |  | Included      | Additional Info needed | Refer to Remarks | Not Applicable |         |
| 1    | Supplement 1: <a href="#">GI-0002.102</a> -1, Checklist for Pressure Testing Safely  | <a href="#">GI-0002.102</a><br>Sec. 5                                      |               |                        |                  |                |         |
| 2    | A pressure test diagram  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 3    | A test manifold arrangement with proof of Hydrotest and NDT of welds. (Test manifolds require revalidation of 36 months for each new project and for existing facilities)  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5;<br>SAES-A-004,<br>Appendix B  |               |                        |                  |                |         |
| 4    | The location of blind flanges and isolation valves, if any. (These locations should be clearly indicated in the Pressure Test diagram.)  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 5    | The location of check valves (flappers should be removed, if necessary, prior to testing)  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 6    | The location of the lowest rated component that determines the test pressure   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 7    | Relief valve size and set pressure along with the size calculation certificate and approval. A plant process or instrument engineer shall approve the relief valve set pressure and adequate relieving capacity. If neither is available consult with personnel in the Consulting Services Department or Process & Control Systems Department, if necessary, to assure that the relief valve has the proper set pressure and adequate capacity | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 8    | The test medium (Air or Nitrogen)  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 9    | The test pressures and holding times. (Minimum 10 min holding times for steps and 30 minutes for final).   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5;<br><a href="#">SAES-L-150</a> |               |                        |                  |                |         |
| 11   | The minimum temperature allowed, if appropriate.   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |
| 12   | Inspection requirements and bubble test pressure   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5;<br>SAES-A-004,<br>ASME SEC V  |               |                        |                  |                |         |
| 13   | Areas to be kept free of people during the test and the location of barricades, if appropriate   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5                                |               |                        |                  |                |         |

| Item | Description   | Reference   | Check Box (✓) |                        |                  |                | Remarks |
|------|---|---|---------------|------------------------|------------------|----------------|---------|
|      |   |   | Included      | Additional Info needed | Refer to Remarks | Not Applicable |         |
| 14   | The location of warning signs and markings for the test areas   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 15   | Work permits required, if any   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 16   | Additional or special personal safety equipment required  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 17   | Safety Instruction Sheets if available and emergency communication required, and the methods  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 18   | Vacuum valve size and set pressure, if any  | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 19   | The location of the filling point   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 20   | Listing of correct sequence and necessary torque of all blind flange bolts and a requirement to verify proper torque when bolting   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 22   | The verification of compliance with the manufacturer's rating specifications (e.g., quality, service use, pressure rating for all gaskets   | <a href="#">GI-0002.102</a><br>Sec. 5.1.2.5   |               |                        |                  |                |         |
| 23   | Tested relief valve(s) (within two weeks) with a tag stamped with the word "TEST", the set pressure and date. The relief valve shall have adequate capacity to prevent overpressure during the test and shall have been tested in accordance with <a href="#">SAEP-319</a> .  | <a href="#">SAEP-319</a> ;<br><a href="#">GI-0002.102</a><br>Sec. 5.1.5.1<br>SAES-A-004<br>Sec. 5.7.1 |               |                        |                  |                |         |
| 24   | A blowdown valve for depressurizing the test piping and a valve to isolate the test piping from the system under test shall be provided   | <a href="#">GI-0002.102</a><br>Sec. 5.1.5.3   |               |                        |                  |                |         |
| 25   | Two or more accurate and reliable pressure gauges with block and bleed valves to permit safe replacement of the gauges, if necessary. The gauges shall have been calibrated within 30 days prior to the test and their range shall be such that the maximum test pressure is within 30 to 80 percent of the full range. One gauge shall be located in the test piping such that it can be read by the pump operator. The other gauge(s) shall be located in the system under test. The pressure gauge calibration stickers should be affixed on the back of the pressure gauge. | <a href="#">GI-0002.102</a><br>Sec. 5.1.5.2;<br>SAES-A-004,<br>5.11.6.3                               |               |                        |                  |                |         |

| Item | Description   | Reference   | Check Box (✓) |                        |                  |                | Remarks |
|------|---|---|---------------|------------------------|------------------|----------------|---------|
|      |   |   | Included      | Additional Info needed | Refer to Remarks | Not Applicable |         |
| 26   | Do not exceed the following pressures until weaknesses have been repaired and leaks have been stopped: Any tests using air or other gas as a test medium: 173 kPa (25 psig) or 50% of the strength test pressure, whichever is the lower value.   | <a href="#">GI-0002.102</a><br>Sec. 5.2.3.2             |               |                        |                  |                |         |
| 27   | After preliminary checks for leaks at the above pressures, the pressure shall be increased in steps with at least 10-minute holds at each step to permit inspection for leaks and weaknesses.<br><br>In strength tests using air or other gas as the test medium, the pressure shall be increased in steps no greater than one-tenth of the strength test pressure after reaching 50% of the test pressure, as required in Section VIII of the ASME Pressure Vessel Code. The procedure shall have a table showing each pressure increase and minimum holding time.   | <a href="#">GI-0002.102</a><br>Sec. 5.2.3.2             |               |                        |                  |                |         |
| 28   | Safe distance calculations shall be performed per ASME PCC-2, Article 501, Mandatory Appendix III, "Safe Distance Calculations for Pneumatic Pressure Test" and attached to the procedure   | <a href="#">GI-0002.102</a><br>Sec. 5.2.5.3             |               |                        |                  |                |         |
| 29   | The maximum calculated stored energy calculation shall be performed per ASME ASME PCC-2, Article 501, Mandatory Appendix II for any vessel or piping system being pneumatically pressure tested and should not be greater than 271 000 000 J (200,000,000 ft-lb). If the calculated stored energy is greater than 271 000 000 J (200,000,000 ft-lb), then one the following shall be adhered to (ASME PCC-2, Article 501 paragraph 6.2.e.):<br><br>(1) The system shall be divided into smaller volumes such that each subsystem has a stored energy not greater than 271 000 000 J (200,000,000 ft-lb)<br>(2) A minimum distance shall be calculated per Mandatory Appendix III, eq. (III-1), and this distance shall be adhered to<br>(3) A barricade per ASME PCC-2, Article 501 paragraph 6.2(g) shall be installed | <a href="#">GI-0002.102</a><br>Sec. 5.2.3.1,<br>5.2.3.2 |               |                        |                  |                |         |

| Item | Description  | Reference                                    | Check Box (✓) |                        |                  |                | Remarks |
|------|--|--|---------------|------------------------|------------------|----------------|---------|
|      |  |  | Included      | Additional Info needed | Refer to Remarks | Not Applicable |         |
| 30   | A detailed hazard analysis should be performed to evaluate the risk associated with the release of stored energy. See ASME PCC-2 Article 501 Mandatory Appendix IV for considerations relative to risk evaluation. Factors to consider in this analysis should include are provided by Article 501 paragraph 6.2 . | ASME PCC-2 Article 501 Mandatory Appendix IV |               |                        |                  |                |         |

## Appendix B - Test Manifold Requirements

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 and not less than the discharge pressure of the pump used for the pressure testing. Following are important requirements shall be followed prior to use testing manifold:

| No | Test Manifold Requirements   |
|----|--|
| 1  | The test manifold shall be designed by the responsible engineering group and constructed to meet the minimum system requirements and approved by the Engineering Division head in operating facilities or responsible PQM/ Sr. Supervisor in new construction.   |
| 2  | All the joints shall be welded. The designer shall specify the weld size in the design in case socket welded manifolds are used. All threaded connections upstream of block valve shall be seal welded.  |
| 3  | Test manifolds shall have 100% NDT of all welds.   |
| 4  | Test manifolds for new construction shall be revalidated for each new project. Suitable NDT shall be performed to verify possible thickness reductions. The manifolds shall be re-rated according to the actual thickness during re-validation process.<br><br>For maintain potential projects and operating facilities, the revalidation shall be every 3 years. The revalidation pressure testing shall be 1.2 times the system test pressure as per GI-0002.102. System requirements include pressure and temperature ratings on the piping and fittings for the equipment and piping being tested.   |
| 5  | Pressure testing manifold package shall be prepared and shall include the following requirements as minimum: <ol style="list-style-type: none"><li>The testing manifold shall be designed by the project designer.</li><li>Material specification and grade for the structural, pipes, fittings, hoses, flanges and gaskets, as applicable. All materials used shall be traceable to manufacturer's test certificates (MTC).</li><li>Pressure and temperature rating for all piping, fittings, hoses, flanges, and the valves.</li><li>For thread type fittings, leak testing shall be conducted using non-detergent based solution to ensure threads full engagement prior to seal weld.</li><li>NDT of the butt and fillet weld joints of the manifold.</li><li>External surface blasting and painting of the manifold (not for Stainless Steel materials).</li><li>Recommended test pressure of the manifold, and the test pressure limits of the manifold.</li><li>A specific serial no. with the approval date of testing shall be assigned to the manifold, for proper traceability.</li></ol> |

### Appendix C - Manifold / Dummy Spool Approval Form

|                               |  |
|-------------------------------|--|
| <b>Test Certificate #</b>     |  |
| <b>Serial #</b>               |  |
| <b>Test Pressure</b>          |  |
| <b>Test Date</b>              |  |
| <b>Re-validation Due Date</b> |  |
| <b>Test Performed By</b>      |  |

The following items shall to be verified before using the test manifold / Dummy Spool:

| No | ITEM   | YES | NO | REMARKS |
|----|--|-----|----|---------|
| 1  | The testing manifold/ Dummy Spool shall be designed by the project designer for new projects or Engineering Group for operating facilities.  |     |    |         |
| 2  | Test manifolds / Dummy Spool shall have 100% NDT of all welds.   |     |    |         |
| 3  | Material specification and grade for the structural, pipes, fittings, hoses, flanges and gaskets.  |     |    |         |
| 4  | Test Certificate (Signed and Stamped)  |     |    |         |
| 5  | Manifold / Dummy Spool arrangement diagram   |     |    |         |
| 6  | Manifold / Dummy Spool components details should be specified on drawings which covers, but not limited, to class, rating, and size. Isolation valves should be one class higher than system tested. |     |    |         |
| 7  | Witness the pressure test by Saudi Aramco Inspector.   |     |    |         |

|                               |                            |
|-------------------------------|----------------------------|
| <b>For New Construction</b>   | PQM/ Sr. Supervisor:       |
| <b>For Operating Facility</b> | Engineering Division head: |

## Appendix D - Hydrotesting with Primed and Painted Joints Conditions

Hydrotesting with primed and painted joints in piping systems may be done if conditions below are met:

| No | Conditions   |
|----|--|
| 1  | Each welder involved in system fabrication shall be a minimum Level "B" welder according to <a href="#">SAEP-324</a> . |
| 2  | Socket and O'let welds shall not be coated prior to hydrotest.   |
| 3  | Minimum holding time shall be 1 hour or 2 times the required holding time, whichever is greater.                       |
| 4  | The service is not lethal or Category M  |

*Note: It is highly recommended to evaluate at the planning stage and prior to fabrication started.*

## Appendix E - Conditions in-Lieu of Instruments Removal

In case instruments are installed and it is not practical to remove them, following conditions in-lieu of instruments removal prior to pressure testing shall be followed:

| No | Conditions   |
|----|--|
| 1  | Non-sensitive equipment/instruments only shall be left in-place (to be approved by Engineering Division Head in operating facilities and contractor in projects and the approval shall be kept in inspection records). |
| 2  | In-place instrument must have been tested at testing pressure in shop.   |
| 3  | Original operations intent of facility shall not be impacted.  |
| 4  | Drainage of test loop shall not be impacted.   |
| 5  | Instrument shall not be damaged during pressure testing.   |
| 6  | Warranty for full replacement shall be provided by contractor in projects.   |

## Appendix F - Specific Testing Requirement

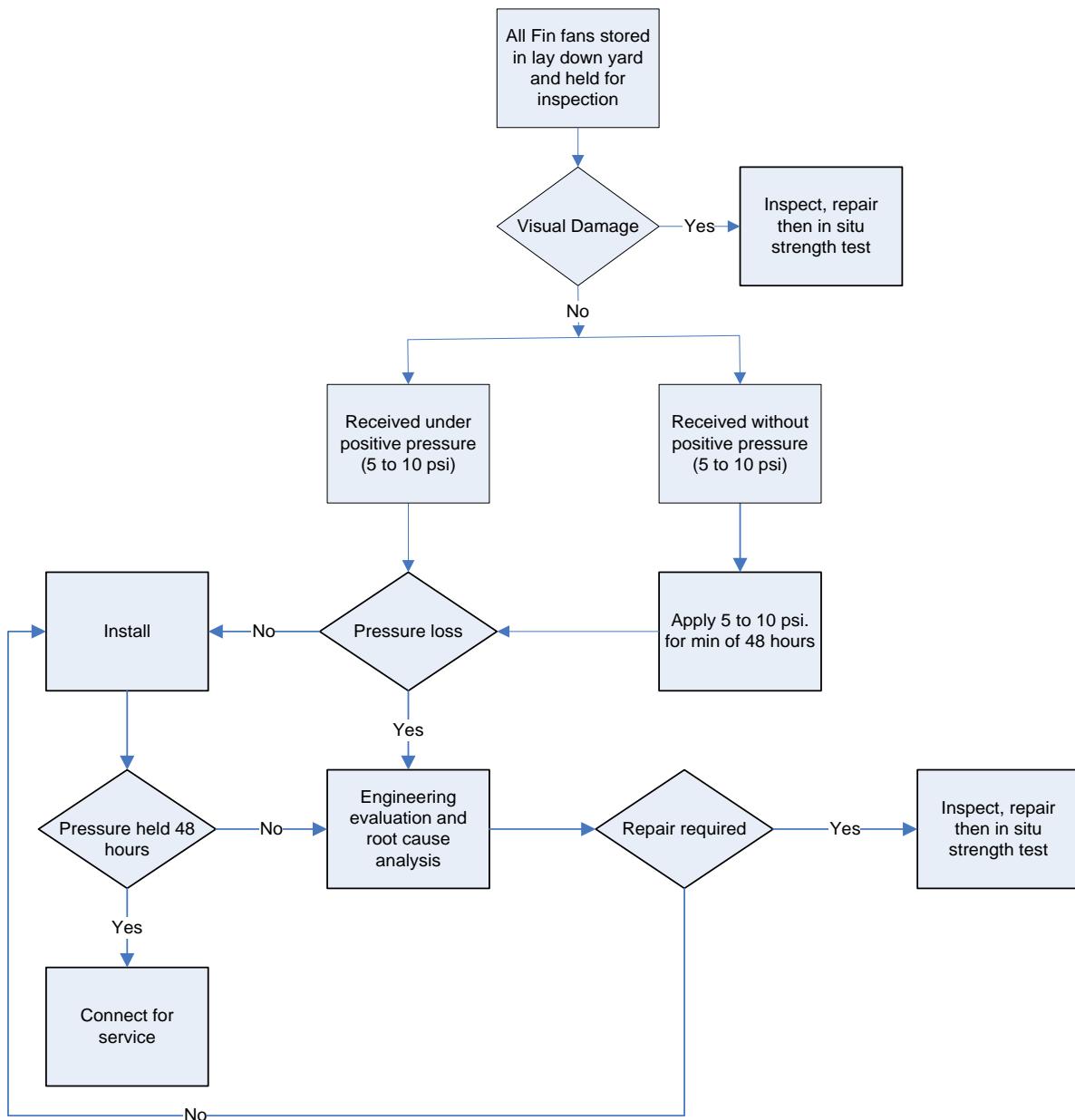
This section specifies in details which piping or equipment that shall be pressure tested and provides the specific applicable standard. It also defines any specific exemptions.

| No | Piping/Equipment        | Specific Applicable Standard  |
|----|-------------------------|---|
| 1  | Plant Piping            | Pressure testing of plant piping shall be in accordance to <a href="#">01-SAMSS-010</a> , <a href="#">SAES-L-150</a> , and <a href="#">SAES-J-901</a> for instrument air piping.  |
| 2  | Cross-Country Pipelines | Pressure testing of cross country pipelines shall be in accordance to <a href="#">01-SAMSS-010</a> and <a href="#">SAES-L-150</a> .   |
| 3  | Pressure Vessels        | <ul style="list-style-type: none"><li>• Hydrostatic testing for new vessels (field fabricated) shall be conducted as per <a href="#">32-SAMSS-004</a> and the original construction code.<br/>Pneumatic test, when approved (refer to paragraph 5.4), shall be conducted per UG-100 of <a href="#">ASME SEC VIII D1</a>, or T-4 of <a href="#">ASME SEC VIII D2</a>, whichever is applicable.</li><li>• Pressure testing of small vessels shall be per the appropriate standard as specified in <a href="#">32-SAMSS-036</a>.</li><li>• Hydrostatic testing for existing vessels shall be conducted per <a href="#">SAES-D-008</a>, Section 14.</li></ul>   |
| 4  | Heat Transfer Equipment | <ul style="list-style-type: none"><li>• Hydrostatic tests for existing equipment shall be in accordance with <a href="#">SAES-D-008</a>.</li><li>• For pneumatic testing, refer to item 3 in this table.</li><li>• Hydrostatic testing of new, field fabricated boilers shall be in accordance with <a href="#">ASME SEC I</a>. For pressure testing after repair or alteration, refer to <a href="#">SAES-D-008</a> and National Board Inspection Code, NBIC. Hydrostatic test during T&amp;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 <a href="#">32-SAMSS-029</a>.</li><li>• Tube bundles which have been removed from the exchanger shell for maintenance purposes (e.g., cleaning, bundles replacement, or repairs as per <a href="#">SAES-D-008</a>) shall be subjected to an in-situ shell and tube side test per <a href="#">SAES-D-008</a> and <a href="#">SAEP-317</a> prior to returning to service.</li><li>• Fin fan exchangers shall be strength tested as specified below:<ol style="list-style-type: none"><li>a) New fabricated fin fan coolers to be strength tested in accordance with <a href="#">32-SAMSS-011</a>.</li><li>b) Modified or repaired fin fan coolers shall be strength tested in accordance with the Safety Instruction Sheet (SIS).</li><li>c) In-situ pressure testing shall be conducted in reference to <a href="#">Appendix G</a>. This is applicable to new and repaired or modified fin fan coolers that passed the shop strength test then transported to site.</li></ol></li></ul> |

| No | Piping/Equipment                       | Specific Applicable Standard  |
|----|--|---|
| 5  | Tanks                                  | <ul style="list-style-type: none"><li>For new, field fabricated tanks, the hydrostatic testing shall be in accordance with <a href="#">32-SAMSS-006</a> for large, low pressure welded tanks; or <a href="#">32-SAMSS-005</a> for atmospheric steel tank.</li><li>For existing tanks, the hydrostatic testing shall be in accordance with <a href="#">32-SAMSS-005</a>, <a href="#">32-SAMSS-006</a>, and <a href="#">SAES-D-108</a> as applicable.</li></ul> |
| 6  | Fire Protection Systems                | Pressure testing of new and existing fire protection systems shall be in accordance with <a href="#">GI-1781.001</a> and <a href="#">SAES-B-017</a> .   |
| 7  | Refrigerant Piping Systems             | Refrigerant piping serving building air conditioning systems shall be tested according to the requirements of <a href="#">SAES-K-001</a> , <a href="#">SAES-K-100</a> , and <a href="#">ASHRAE Std 15</a> and <a href="#">Std 34</a> .  |
| 8  | Potable Water Systems                  | <ul style="list-style-type: none"><li>Potable water piping inside buildings shall be tested in accordance with the requirements of the Uniform Plumbing Code (<a href="#">UPC</a>). Exceptions to <a href="#">UPC</a> requirements are listed in <a href="#">SAES-S-060</a>.</li><li>Potable water piping outside of buildings shall be tested in accordance with the requirements of <a href="#">SAES-S-040</a>.</li></ul>                                   |
| 9  | Non-metallic Utility Piping Systems    | Utility piping systems, including irrigation piping and water distribution mains, shall be tested in accordance with <a href="#">SAES-S-070</a> .<br><br>At the company's option, a piping system in Category D fluid service may be subjected to an initial service leak test in accordance with ASME B31.3 paragraph 345.7, in lieu of the hydrostatic leak test.   |
| 10 | Industrial Drainage and Sewers         | Industrial drainage and sewers shall be tested in accordance with <a href="#">SAES-S-020</a> .  |
| 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 <a href="#">SAES-S-060</a> .  |
| 12 | Storm Water Drainage Systems           | Sanitary sewer lines outside of buildings shall be tested in accordance with <a href="#">SAES-S-070</a> .   |
| 13 | Miscellaneous Building Services Piping | Steam and condensate piping outside the jurisdiction of <a href="#">ASME B31.3</a> , heating and cooling water piping, vacuum and compressed air system piping for building services shall be tested per requirements of <a href="#">ASME B31.9</a> , Building Services Piping.   |
| 14 | Valves                                 | Valves shall be tested in accordance with <a href="#">SAES-L-108</a> , <a href="#">04-SAMSS-048</a> , <a href="#">SAEP-35</a> , and API STD 598.  |
| 15 | Non-Metallic Piping                    | Non-metallic piping such as RTR, Thermoplastic, PVC/UPVC and CPVC shall be tested in accordance with <a href="#">SAES-S-070</a> , <a href="#">SAES-L-650</a> , and <a href="#">SAEP-384</a> .   |
| 16 | Gasket Material                        | All gaskets used in the pressure test shall conform to the specifications per <a href="#">SAES-L-109</a> .  |
| 17 | Internally Coated Equipment or Piping  | The hydrotest pressure of all internally coated vessels, tanks or piping shall be reviewed against the coating limitations as per <a href="#">SAES-H-001</a> .  |

| No | Piping/Equipment      | Specific Applicable Standard   |
|----|-----------------------|--|
|    |                       | On completing the hydrostatic test, the pressure should be reduced gradually to prevent decompression failure of the internal coating. |
| 18 | CRA Clad Pipe Spools. | Pressure testing of CRA Clad Pipe Spools shall be in accordance to <a href="#">01-SAMSS-044</a> , <a href="#">SAES-L-150</a> .         |
| 19 | Laterals              | Pressure testing of Laterals shall be in accordance to <a href="#">01-SAMSS-010</a> , SAES-L-110 and <a href="#">SAES-L-150</a> .      |

## Appendix G - Decision Tree for In-situ Strength Testing of Fin Fan Coolers



## Appendix H - Sample Form of Request for Non-Destructive Testing In-Lieu of Hydrostatic Test for Facilities under Construction<sup>(a)(b)(c)</sup>

[ ] RT [ ] Encoded PAUT [ ] Manual PAUT [ ] MT [ ] PT [ ] MUT

BI/JO/WO Number: \_\_\_\_\_ DATE: \_\_\_\_\_

ORIGINATOR ENGR (SAPMT): \_\_\_\_\_ UNIT: \_\_\_\_\_

TITLE: \_\_\_\_\_

ORGANIZATION: \_\_\_\_\_ ADDRESS: \_\_\_\_\_ PHONE: \_\_\_\_\_

=====

PRESENT SITUATION:

\_\_\_\_\_

JUSTIFICATION:

\_\_\_\_\_

CONDITIONS OF APPROVAL:

\_\_\_\_\_

REASONS FOR DISAPPROVAL:

\_\_\_\_\_

UNIT HEAD, ORIGINATOR (SAPMT) CONCUR: \_\_\_\_\_

UNIT HEAD, PROJECT INSPECTION UNIT CONCUR: \_\_\_\_\_

CONCUR: \_\_\_\_\_

SAPMT PROJECT MANAGER

APPROVED BY <sup>(d)</sup> \_\_\_\_\_

SENIOR OPERATIONS' REPRESENTATIVE

### CONDITIONS:

- 1- Utilize skilled welders with rejection rate of less than 5% on a joint basis and 0.2% on a linear basis in the most recent past twelve (12) months.
- 2- Use Saudi Aramco approved Welding Procedure Specification (WPS).
- 3- Visually inspect the root, hot, fill and cap passes during the welding process with a Saudi Aramco inspector.
- 4- Perform 100% radiographic testing (RT) of butt welds.
- 5- Perform 100% phased array ultrasonic testing (PAUT) of all welds (e)(f)(g). Socket welds are exempt from PAUT
- 6- When encoded PAUT cannot be performed (e.g. due to geometry restrictions, attachments, etc.), manual PAUT or manual conventional UT can be utilized after obtaining Inspection Department/ITSD/CNDT&PSU approval. The use of manual PAUT or manual conventional UT shall be limited to the restricted inspection zones of the weld.
- 7- When manual PAUT or manual conventional UT cannot be applied on restricted inspection zones, then MT or PT fluorescent shall be utilized along with 100% RT after obtaining Inspection Department/ITSD/CNDT&PSU approval. The use of MT or PT fluorescent shall be limited to the restricted inspection zones of the weld.
- 8- For O'let and socket inspection, it is required to perform manual UT, if inspection zone is accessible. Also, perform PT or MT after completion of each weld pass.
- 9- For Category D or "Utility" Fluid service welds, only one NDT method needs to be applied, i.e. 100% manual conventional UT or RT.
- 10- Radiographic film to be interpreted by senior RTFI Level II personnel with a minimum of 5 years post qualification/interpretation experience and advanced UT by PAUT Level III personnel or UT Level III personnel, who is certified to minimum level II in PAUT.
- 11- All NDT personnel shall have passed Saudi Aramco verification exam in the applicable NDT method and/or technique as per SAEP-1140 for Saudi Aramco NDT personnel and SAEP-1142 for non-Saudi Aramco NDT personnel.

**NOTES:**

- a. Sketch or drawing showing location of all welds to be radiographed, qualifications of the welder(s) and the approved Welding Procedure Specification shall be attached.
- b. Design information such as line/equipment number, wall thickness, material, service conditions, operating pressure and temperature shall also be included.
- c. This form shall be processed and approved prior to NDT as follows:
  - Minimum fifteen (15) working days prior for new facilities under construction in projects.
  - Minimum five (5) working days prior for existing operating facilities during normal operation and the whole unit/area is not shut-down.
  - Minimum forty-eight (48) hours prior for existing operating facilities during T&I and the whole unit/area is shut-down
- d. Refer to Paragraph 4.2 for Senior Operations' Representative
- e. Utilize computer modeling software to illustrate PAUT weld examination coverage.
- f. PAUT procedure and computer model shall be reviewed by ID/ITSD.
- g. Pipeline mechanized welding per [SAES-W-012](#) using the GMAW process in the short-circuiting or pulsing mode requires 100% ultrasonic inspection using a computerized automated ultrasonic inspection system. Automated UT is the code compliant (primary) weld inspection method.
- h. Socket welds shall be inspected using liquid penetrant or magnet particle examination

## Appendix I - Sample of [SA-2642](#) Pressure Test Report Form

### SAUDI ARAMCO PRESSURE TEST REPORT

SAUDI ARAMCO [SA-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: \_\_\_\_\_ MAWP: \_\_\_\_\_ 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:

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