

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

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SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

1 OF 18

CONTENTS

1. SCOPE
2. PURPOSE
3. REFERENCES
4. HAZARDS OF PRESSURE TESTING
5. PRINCIPLES OF SAFE PRESSURE TESTING
6. APPROVALS AND REVIEWS

SUPPLEMENT 1: GI 2.102-1, Checklist for Pressure Testing Safely

1. SCOPE

- 1.1 This instruction provides general information, requirements and guidelines on safe pressure testing of new and existing mechanical systems such as piping, pipelines, pressure vessels, and power boilers (hereinafter called systems). It applies to all pressure testing in Saudi Aramco facilities, such as hydrostatic, pneumatic, and service strength testing and tightness or leak testing, except as covered in Paragraph 1.2. Pressure testing procedures and other documents issued by responsible organizations shall be consistent with this instruction.
- 1.2 This instruction does not cover pressure testing of low pressure or atmospheric pressure storage tanks, or equipment associated with drilling and workover operations such as blowout preventors, wellheads, wells, and well tubulars, although portions of this instruction should be useful to those preparing pressure testing procedures for such facilities.
- 1.3 This instruction is not intended to conflict with standards or codes used by Saudi Aramco such as those for piping, pipelines, pressure vessels, and power boilers. Any such conflicts that arise shall be referred to the Chief Engineer, Engineering Organization, Dhahran.

2. PURPOSE

The purpose of this instruction is to prevent injuries, fatalities, and property damage during pressure testing by ensuring that:

- (a) Pressure testing procedures are developed and that they include safety aspects of pressure testing.
- (b) Pressure testing procedures are approved as required in this GI and that these procedures are followed by the organization responsible for pressure testing.

3. REFERENCES

- SAES-A-004: General Requirements for Pressure Testing
- SAES-A-007: Hydrostatic Testing Fluids and Lay-Up Procedures
- GI 2.100: Work Permit System

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

2 OF 18

- SAEP 310: Piping and Pipeline Repair
- SAEP 311: Installation of Hot Tapped and Stopple Connections
- SAEP 318: Pressure Relief Valve Program Authorization for Installation, Deletion and Changes
- SAEP 319: Pressure Relief Valves – Routine Test, Inspection, Quality Assurance and Regulation
- SAEP 327: Disposal of Wastewater from Cleaning, Flushing and Dewatering Pipelines and Vessels
- American Society of Mechanical Engineers (ASME) Pressure Vessel Code, Sections I and VIII

4. HAZARDS OF PRESSURE TESTING

Mishaps and failures during pressure testing may result in injuries, fatalities, and property damage. The greatest potential hazard is an uncontrolled release of the large amount of energy that can be stored in compressed air, gas or other fluid, either in a pneumatic test or in a hydrostatic test, where gas may be trapped in such places as unvented high points, horizontal lines, and valve bodies. Other hazards are associated with the handling of chemical additives, entering confined spaces, brittle fracture of materials, and disposal of test mediums.

Uncontrolled releases of stored energy from compressed air or other gas can take the form of explosions. High velocity streams of fluid can be created or piping and equipment can move. The degrees of these hazards are determined primarily by the test pressure and the volume of air, gas or other fluid involved.

Avoid the following typical examples of poor practices which may result in incidents:

- Striking or working on equipment, while it is under pressure, to stop leaks
- Improper or missing test equipment, such as testing without a relief valve, having an inadequately sized relief valve, or having no pressure gauge(s)
- Omitting or changing steps in the test sequence such as failing to conduct a low pressure tightness test to check for leaks prior to strength pressure tests at higher pressures
- Failure to vent air from the system prior to the test
- Use of gas instead of water as a test medium
- Metal temperature below that at which the impact requirements can be met by the material
- System not adequately supported to withstand the weight of water during the test
- Pressure gauge(s) and relief valve(s) not calibrated and tested
- Pressure gauge located too far from pressurizing equipment for reading
- Appurtenances not adequate for the test pressure or not isolated from the test
- Pressure increased too rapidly to be controlled
- Relief valve inoperative because of a closed block valve
- Temporary test piping not designed for the test pressure
- No bleed valve provided on test piping
- Failure to pressure test the test equipment and piping prior to putting them in service

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

3 OF 18

- Testing equipment with the test gauge located at the bottom of the equipment reading the test pressure, including the head of test water

5. PRINCIPLES OF SAFE PRESSURE TESTING

** Supplement 1: GI 2.102-1, Checklist for Pressure Testing Safely, shall be completed as required before, during, and after the test. Before issuing the hydrotest work permit, the checklist portion (before the test) shall be completed. This checklist shall be kept with the hydrotest work permit.

Pressure testing procedures shall be consistent with the following:

5.1 Before Start of Test

5.1.1 Assign Responsibility

5.1.1.1 The proponent organization shall assign persons to be responsible for:

- (a) Preparation of the test procedures.
- (b) Delivery of the approved test procedures to job sites.
- (c) Safety aspects of the pressure test.
- (d) Coordination and implementation of the pressure test in a safe manner.

5.1.1.2 For major tests, representatives from Inspection and the responsible proponent organization shall monitor testing.

Major tests include tests on: pipelines such as cross-country pipelines, submarine pipelines, flowlines, trunklines, water injection pipelines, and gas lift pipelines; pressure vessels or in-plant piping with a volume over 5.7 cubic meters (200 cubic feet); and power boilers.

5.1.1.3 Before any test(s) are carried out, the proponent organization shall thoroughly inspect equipment, where practicable.

5.1.2 Issue Written, Approved Procedures

* 5.1.2.1 Prior to writing and issuing test procedures, historical documentation (e.g., design data sheets, inspection reports and safety instruction sheets) for the equipment to be tested shall be reviewed.

5.1.2.2 The issuer of the procedure shall consult with plant process and/or instrument engineer to review the test relief valve size and capacity to ensure it is adequate for the pressure test and size of the tested system.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

4 OF 18

- 5.1.2.3 Written, approved procedures shall be provided to all concerned personnel at least two days before testing, and be available at the job sites for pressure tests with a high hazard potential, such as those on cross country pipelines of all kinds, plant piping, pressure vessels, and power boilers.
- 5.1.2.4 Written procedures are not mandatory for tests on household utilities, irrigation sprinkler systems, and low pressure, pneumatic leak tests on reinforcing pads and the annuli of weld-plus-end couplings, per SAEP 310.
- 5.1.2.5 The following information shall be included in each test procedure as a minimum:
- (a) A pressure test diagram or hydrostatic test diagram.
 - (b) A test manifold arrangement.
 - (c) The location of blind flanges and isolation valves, if any.
 - (d) The location of check valves (flappers should be removed, if necessary, prior to testing).
 - (e) The location of the lowest rated component that determines the test pressure.
 - (f) The location of air vents, if appropriate.
 - (g) Relief valve size and set pressure.
 - (h) The test medium.
 - (i) The test pressures.
 - (j) Special support requirements, if any, to take the weight of test liquid.
 - (k) Chemical additives, if any.
 - (l) The test sequence.
 - (m) The minimum temperature allowed, if appropriate.
 - (n) Inspection requirements.
 - (o) Areas to be kept free of people during the test and the location of barricades, if appropriate.
 - (p) The location of warning signs and markings for the test areas, if appropriate.
 - (q) Work permits required, if any.
 - (r) The test medium disposal method.
 - (s) Additional or special personal safety equipment required.
 - (t) Safety Instruction Sheets and emergency communication required, and the methods.
 - (u) Vacuum valve size and set pressure, if any.
 - ** (v) The location of the filling point.
 - ** (w) Listing of correct sequence and necessary torque of all blind flange bolts and a requirement to verify proper torque when bolting.
 - ** (x) The use of properly rated gaskets.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

5 OF 18

** (y) The verification of compliance with the manufacturer's rating specifications (e.g., quality, service use, pressure rating) for all gaskets used.

** 5.1.2.6 All important information on test pressures (e.g., timing and duration at every pressure rise step) shall be recorded.

5.1.3 Use Proper Test Medium

5.1.3.1 Water shall be the pressure test medium for pipelines such as cross-country pipelines, submarine pipelines, flowlines, trunklines, water injection pipelines and gas lift pipelines. Water shall also be the pressure test medium for other facilities except those as allowed per SAES-A-004. Whenever the test medium requirements of SAES-A-004 are not practicable, approval is required from the Manager of the Inspection Department.

5.1.3.2 Air shall not be permitted as a pressure test medium in a system that was in hydrocarbon service unless the system has been cleaned to avoid an explosive hydrocarbon-air mixture.

5.1.3.3 The following shall never be used as pressure test mediums because they are extremely hazardous:

- oxygen
- toxic gases
- liquids above their flash points or atmospheric boiling points
- liquids above 66 deg. C (150 deg. F), except where necessary for pressure testing hot-tapping connections on hot lines per SAEP 311, Installation of Hot Tapped and Stopple Connections.

5.1.3.4 Steam may be used as a pressure test medium only in tightness tests and service tests.

5.1.3.5 When a liquid above 49 deg. C (120 deg. F) and below 66 deg. C (150 deg. F) is used as a pressure test medium, such as the use of aquifer water in testing water injection lines, personnel involved with the test shall wear appropriate personal protective equipment to protect against exposure to hot liquid.

5.1.3.6 Non-toxic liquids other than water may be used for pressure testing if the operating fluid or equipment can be adversely affected by water or freezing conditions. Refer to SAES-A-007 for more details.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

6 OF 18

5.1.4 Select and Treat Hydrostatic Test Water

To avoid corrosion and possible resulting failures from hydrostatic test water, the requirements of SAES-A-007 for chemical treatment and selection of hydrostatic test water shall be followed.

5.1.5 Use Appropriate Test Equipment

Appropriate test equipment shall be used to assure a controlled pressure increase, no overpressure, and safe depressurization. The following are minimum requirements:

5.1.5.1 Tested relief valve(s) with a tag stamped with the word "TEST", the set pressure, and date as covered in SAEP 318 and SAEP 319. The relief valve shall have adequate capacity to prevent overpressure during the test and shall have been tested in accordance with SAEP 319. The relief valve shall be located in the system under test and near the test pump or other test medium supply. No block valve shall be provided in the relief valve's inlet or outlet with the following exception: if the relief valve is to be installed on an existing valve connection and removing the valve is not practical because of fluid in the system, this valve may be on the relief valve's inlet provided it is sealed open during the test.

A plant process or instrument engineer shall approve the relief valve set pressure and adequate relieving capacity. 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.

5.1.5.2 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.

5.1.5.3 A blowdown valve for depressurizing the test piping and a valve to isolate the test piping from the system under test shall be provided. Provide a readily accessible blowdown valve on the system under test for the purpose of draining test fluid. The fluid shall be piped or drained to a designated location, drain or area.

5.1.5.4 The test equipment is not required for tests on household utilities, irrigation sprinkler systems, and low pressure pneumatic leak tests on reinforcing pads and the annuli of weld-plus-ends couplings per SAEP 310, "Piping and Pipeline Repair." For these tests, the test equipment shall be selected by the person responsible for the test.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

7 OF 18

5.1.5.5 Any manifold for pressure testing purposes, either for permanent or temporary usage, shall be tested separately from any other piping before it is used in conjunction with the testing of any system. The manifold shall be designed for and tested to a pressure not less than 20 percent above the maximum test pressure to be applied on the system to be tested, except for the final connection between the test manifold and the system under test, which may be designed for and tested to the maximum system test pressure where a higher pressure is not feasible.

5.1.6 Obtain Work Permits

Work permits shall be obtained for all pressure testing and associated work within restricted areas as covered in GI 2.100, Work Permit System.

5.1.7 Isolate Equipment Not Adequate for Test Pressures

Appurtenances not part of the pressure test shall be blinded to exclude equipment which cannot withstand the test pressure. If isolation valves are used in lieu of blinds, provisions shall be made to ensure that no overpressuring can occur in equipment that is not being tested, due to possible valve leak.

5.1.8 Prevent Overloads from Weight of Liquid

Portions of the system such as supports, vessels, piping, and foundations shall not be overloaded by the weight of a test liquid. Prevent overloads by using such means as combining hydrostatic and pneumatic tests for columns and providing temporary supports, where necessary. Prior to the start of any such test, Consulting Services Department shall be consulted, if necessary, to ensure that the system to be tested can withstand the weight of the test liquid.

5.1.9 Handle Chemicals Safely

Materials Safety Data Sheets or Chemical Hazard Bulletins from the Environmental Protection Department's website shall be reviewed for all chemicals handled such as corrosion inhibitor, bactericide, chlorine, and oxygen scavenger, and a written procedure to safely handle chemicals during testing, and proper disposal of the chemicals after testing, shall be approved prior to start of the work. Personal protective equipment shall be utilized as shown on these sheets and bulletins.

5.1.10 Avoid Failure by Brittle Fracture

The metal temperature during a pressure test shall be in accordance with SAES-A-004, General Requirements for Pressure Testing.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

8 OF 18

Consult with a plant process engineer and Inspection Department before testing pressure vessels with unknown material impact properties to determine the minimum allowable test temperature.

5.1.11 Control Access to the Site

5.1.11.1 In plant areas and shops the test area shall be marked and warning signs shall be posted to alert approaching personnel, where practical.

5.1.11.2 Personnel shall be posted at plant sites to keep the test area clear of all people not connected with the test, if necessary.

5.1.11.3 When pipelines, flowlines, or other systems outside of plant areas are tested, warning signs shall be placed at locations where people could be exposed, such as road crossings.

5.1.11.4 Where a pipeline being tested crosses under a road, the traffic shall be diverted or stopped during the test, if practical. If this is not practical, personnel shall be posted at the crossing to control traffic in the event of an incident affecting traffic safety.

5.1.11.5 Where a road parallels within 30 m (100 ft.) of an aboveground pipeline being tested, traffic shall be diverted or stopped during the test. If this is not practical, the responsible area Loss Prevention office should be contacted to confirm that the test can be conducted safely.

5.1.12 Advise Saudi Aramco Affairs of Non-Saudi Aramco Exposures

If non-Saudi Aramco facilities will be exposed in a pressure test of Saudi Aramco facilities, the proponent organization of the test shall so inform the Saudi Aramco Affairs representative prior to the test.

5.1.13 Notify Industrial Security of Tests Requiring Traffic Control

Notify Industrial Security of tests requiring their involvement in controlling traffic at the test site such as tests of pipelines which cross roads.

5.1.14 Publicize Tests Interfering with Traffic

Publicize in the Saudi Aramco Weekly Highlights tests that will interfere with highway traffic. Choose the time of the test so it does not occur during peak traffic hours, if possible.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

9 OF 18

5.2 During and After Test

5.2.1 Personnel working on a pressure test shall always wear the required personal protective equipment (PPE).

5.2.2 Remove Air Before Pressurizing (Liquid Test)

To reduce the amount of stored energy in tests where a liquid is the test medium, air shall be removed from the system through vents at high points while the system is filled at the low point. In pipelines equipped with scraping facilities, air removal can be achieved by using scrapers to displace air with liquid.

5.2.3 Control Pressure Rise

5.2.3.1 The pressure rise during a pressure test shall be gradual and under control to allow time for material to strain, and time for personnel to check for leaks.

5.2.3.2 Do not exceed the following pressures until weaknesses have been repaired and leaks have been stopped:

- Strength tests using a liquid test medium: 50 percent of the strength test pressure.
- Any tests using air or other gas as a test medium: 173 kPa (25 psig) or 50 percent of the strength test pressure, which ever is the lower value.
- Units: 1 Bar = 100,000 N/m² = 100 kPa = 14.5 psi

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.

5.2.3.3 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 percent of the test pressure, as required in Section VIII of the ASME Pressure Vessel Code.

5.2.3.4 In strength tests using a liquid as the test medium, the pressure shall be increased in steps no greater than one-fifth of the strength test pressure after the preliminary check at 50 percent of the strength test pressure.

5.2.3.5 Do not proceed to a higher pressure after each of the above steps until weaknesses have been repaired and leaks have been stopped.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

10 OF 18

5.2.4 Depressurize Before Stopping Leaks or Repairing

Working on a system while it is under pressure is very hazardous because a failure could be initiated by the work due to the addition of stresses in the material. Therefore, a system shall be depressurized (with the exception of pressure due to a head of liquid) before any work is done to stop leaks or repair weaknesses, including the tightening of bolts. In a tightness test, bolts may be tightened without depressurizing if specifically approved in the written procedure.

5.2.5 Restrict Approach to the System

5.2.5.1 Vessels never previously tested or vessels with welds never previously tested are not to be approached during the step-wise increase in pressure. The pressure at which the system under test will be approached for close inspection shall be specified in the test procedure.

5.2.5.2 Personnel carrying out the test shall be provided with a safe place from which the progress of the test can be observed and controlled.

5.2.5.3 Safety clearance distances shall be reviewed by the proponent organization for each individual test, and safe clearance distances shall form part of the test procedure. Loss Prevention Department and Inspection Department shall be consulted for advice, if necessary.

5.2.5.4 Only personnel involved with the test shall be allowed near the system at any time during the test.

5.2.5.5 The test pump, if any, shall be located such that the pump operator will not be exposed to danger in the event of a failure.

5.2.6 Depressurize Safely

5.2.6.1 Upon completion of the test, the system shall be emptied in such a way as not to cause vacuum and collapse. The depressurizing valve and piping shall be arranged for safe discharge of the test medium upon completion of the test. Do not depressurize a system by loosening bolts in a flange or by unscrewing fittings because this could lead to injury.

5.2.6.2 Some systems, such as those with heat exchangers, may have to be depressurized slowly and monitored with pressure gauges to avoid damage to internals such as tubesheets, which may not be designed for the momentary differential pressure that could occur with a rapid depressurization.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

11 OF 18

5.2.7 Dispose of Test Mediums Safely

Written procedures approved prior to testing shall be followed for the disposal of test mediums containing chemical additives for control of corrosion and bacteria. Consult with the Environmental Protection Department for proper disposal methods per the requirements of SAEP 327, Disposal of Wastewater from Cleaning, Flushing and Dewatering Pipeline and Vessels.

5.2.8 Follow Additional Safety Precautions

- 5.2.8.1 Allow the temperature of the test medium to equalize with the environment to the extent practical before pressurizing the system to prevent abnormal pressure changes.
- 5.2.8.2 Attend the test pump at all times during the test unless isolated from the system.
- 5.2.8.3 Isolate the test piping with its isolation valve and bleed down its pressure when not needed to avoid a possible failure.
- 5.2.8.4 Once the test is completed, do not leave the test system unattended. If it is left unattended, then the vent has to be kept open to prevent temperature changes from causing an overpressure or vacuum.
- 5.2.8.5 Keep the test relief valve installed until the test liquid has been drained to prevent possible overpressure due to thermal expansion.
- 5.2.8.6 Drain liquid from a system slowly and with the vents open to prevent a possible vacuum.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL

ISSUING ORG. LOSS PREVENTION DEPARTMENT

SUBJECT PRESSURE TESTING SAFELY

G. I. NUMBER Approved

2.102

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

APPROVAL

HJK

PAGE NO.

12 OF 18

6. APPROVALS AND REVIEWS

Prior to testing, pressure testing procedures where required by this instruction shall be submitted by the party responsible for the test to the responsible inspection group for review and concurrence. Approval by the Manager of the Inspection Department shall be per SAES-A-004.

CONCUR:

MANAGER
Inspection Department

DATE:

CONCUR:

CHIEF ENGINEER

DATE:

APPROVED:

MANAGER
Loss Prevention Department

DATE:

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

13 OF 18

SUPPLEMENT 1**CHECKLIST FOR PRESSURE TESTING SAFELY**

** This GI checklist shall be completed as required before, during, and after the test. Before issuing the hydrotest work permit, the checklist portion (before the test) shall be completed. This checklist shall be kept with the hydrotest work permit.

(Paragraph numbering coincides with Section 5 of this GI for ease of reference.)

5.1 BEFORE START OF TEST

- √ = Yes or satisfactory
 X = No or not satisfactory
 NA = Not Applicable

5.1.1 ASSIGN RESPONSIBILITY

- _____ Proponent organization has assigned persons responsible for the test.
 _____ For major tests, representatives from Inspection and the responsible proponent organization shall monitor testing.
 _____ Before any test(s) are carried out, the proponent organization shall inspect equipment, where applicable.

5.1.2 ISSUE WRITTEN, APPROVED PROCEDURES

- _____ Written, approved procedures are at the job site.
 (Exceptions: Written procedures are not mandatory for certain tests, e.g., household utilities.)
 _____ Procedures are approved by proper authority.
 ** _____ All important information on test pressures (e.g., timing and duration at every pressure rise step) are recorded.
 _____ Procedures include minimum requirements as follows:
- Pressure test or hydrostatic test diagram
 - Test manifold arrangement
 - Location of blind flanges and isolation valves
 - Location of check valves (flappers to be removed, if necessary)
 - Location of lowest rated component that determines test pressure
 - Location of air vents
 - Relief valve size and set pressure
 - Vacuum valve size and set pressure
 - Test medium
 - Test pressures

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

14 OF 18

- Special support requirements
- Chemical additives
- Test sequence
- Minimum temperature allowed
- Inspection requirements
- Areas to be kept free of people
- Location of barricades
- Location of warning signs and markings for test area
- Work permits required
- Test medium disposal method
- Additional or special personnel safety equipment required
- Safety Instruction sheets
- Emergency communication required and the methods
- ** Location of the filling point
- ** Listing of correct sequence and necessary torque of all blind flange bolts and a requirement to verify proper torque when bolting
- ** Use of properly rated gaskets
- ** Verification of compliance with the manufacturer's rating specifications (e.g., quality, service use, pressure rating) for all gaskets used

5.1.3 USE PROPER TEST MEDIUM

- _____ Is water the test medium?
- _____ If not, is the use of a test medium other than water justified?
- _____ If water is not the test medium, are precautions taken to prevent hazardous conditions?
- _____ Personnel have personal protective equipment for protection against burning from hot water.

5.1.4 SELECT AND TREAT HYDROSTATIC TEST WATER

- _____ SAES-A-007 followed for selection and treatment of hydrostatic test water.

5.1.5 USE APPROPRIATE TEST EQUIPMENT

- _____ Equipment includes minimum requirements as follows:
(Exceptions: Certain tests will not need all equipment listed, i.e. household utilities)
- _____ Relief valve tested in accordance with SAEP 319, tagged "TEST" with set pressure and date.
- _____ Relief valve has adequate capacity (consult with Consulting Services Department or Process & Control Systems Department, if necessary).
- _____ Relief valve has proper set pressure (consult with Consulting Services Department or Process & Control Systems Department, if necessary).
- _____ No block valve in relief valve's outlet.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

15 OF 18

- _____ No block valve in relief valve's inlet. (Exception: Relief valve may be installed on existing valve connection if removal of the valve is not practical because of liquid in the system, but the valve must be sealed open during the test.)
- _____ Relief valve located in system under test and near test pump or other test medium supply.
- _____ Two or more accurate and reliable pressure gauges of proper range calibrated within 30 days of the pressure test.
- _____ Pressure gauges have block and bleed valves.
- _____ Pressure gauges are in proper locations.
- _____ Pressure gauges at the test pump or test medium supply can be read by the operator.
- _____ Blowdown valve on test piping.
- _____ Isolation valve on test piping.
- _____ Blowdown valve on system under test readily accessible and piped or draining to a designated location, drain or area.
- _____ Test piping pressure tested to at least 20 percent above test pressure of the system under test. (Exception: Final connection between test manifold and system under test may be tested to maximum system test pressure only if a higher test pressure is impractical.)

5.1.6 OBTAIN WORK PERMITS

- _____ Necessary work permits obtained
- _____ Cold work
- _____ Hot work
- _____ Confined space entry
- _____ Release of hazardous materials

5.1.7. ISOLATE EQUIPMENT NOT ADEQUATE FOR TEST PRESSURES

- _____ Appurtenances that are not part of the test are isolated during the test.
- _____ Provisions made to ensure that no overpressuring can occur in equipment that is not being tested.

5.1.8 PREVENT OVERLOADS FROM WEIGHT OF LIQUID

- _____ Will the weight of the test liquid overload the system?
- _____ If so, are temporary supports or other means provided to prevent overload? Consult with Consulting Services Department for appropriate stress calculations, if necessary.

5.1.9 HANDLE CHEMICALS SAFELY

- _____ Personnel use protective equipment for handling chemicals according to the Materials Safety Data Sheets or Chemical Hazard Bulletins from the Environmental Protection Department's website.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER Approved

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

16 OF 18

5.1.10 AVOID FAILURE BY BRITTLE FRACTURE

- _____ Temperature of the test medium is above the temperature at which the impact requirements are met by the material to avoid a brittle fracture, as per SAES-A-004, General Requirements for Pressure Testing.

5.1.11 CONTROL ACCESS TO THE SITE

- _____ In plant areas and shops, the test area shall be marked and warning signs are posted to alert approaching personnel, where practical.
- _____ Personnel are posted at the plant site to keep the test area clear of all people not connected with the test, if necessary.
- _____ For systems outside of plant areas, warning signs are placed at locations where people could be exposed.
- _____ For a pipeline crossing underneath a road, traffic is diverted or stopped during the test, or personnel are posted.
- _____ For an above ground pipeline parallel to a road within 30 m (100 ft), traffic is diverted or stopped during the test, or a waiver is granted. If this is not practical, the responsible area Loss Prevention office should be contacted to confirm that the test can be conducted safely.

5.1.12 ADVISE SAUDI ARAMCO AFFAIRS OF NON-SAUDI ARAMCO EXPOSURES

- _____ If non-Saudi Aramco facilities will be exposed in a pressure test of Saudi Aramco facilities, Saudi Aramco Affairs will be notified.

5.1.13 NOTIFY INDUSTRIAL SECURITY OF TESTS REQUIRING TRAFFIC CONTROL

- _____ Industrial Security is notified of tests requiring their involvement in controlling traffic at the test site.

5.1.14 PUBLICIZE TESTS INTERFERING WITH TRAFFIC

- _____ Tests that will interfere with traffic are publicized in the Saudi Aramco Highlights and Notices. The time of the test should not occur during peak traffic hours, if possible.

5.2 DURING AND AFTER TEST

- 5.2.1** _____ Personnel shall wear the required personal protective equipment (PPE).

5.2.2 REMOVE AIR BEFORE PRESSURIZING (LIQUID TEST)

- _____ High point vents open while system is filled at the low point.
- _____ Vents are closed after air is removed from the system. (Exception: Pipelines having air removed with scrapers are not vented and filled per the above.)

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER *Approved*

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

17 OF 18

5.2.3 CONTROL PRESSURE RISE

- _____ Pressure is increased gradually with at least 10-minute holds at each step in a strength test.
- _____ Weaknesses are repaired and leaks are stopped before exceeding 50 percent of the strength test pressure for tests using liquid or 173 kPa (25 psig)/50 percent of the strength test pressure, whichever is the smaller, for any tests using air or other gas as the test medium.
- _____ In strength tests using air or other gas, the pressure is increased in steps no greater than one-tenth of the strength test pressure after reaching 50 percent of the test pressure.
- _____ In strength tests using liquid, the pressure is increased in steps no greater than one-fifth of the test pressure after reaching 50 percent of the test pressure.
- _____ Weaknesses are repaired and leaks are stopped before proceeding to any higher pressure.

5.2.4 DEPRESSURIZE BEFORE STOPPING LEAKS OR REPAIRING

- _____ Pressure is removed, except pressure due to head of liquid, before stopping leaks or repairing, including tightening of bolts. (Exception: Bolts may be tightened in a tightness test if specifically approved).

5.2.5 RESTRICT APPROACH TO THE SYSTEM

- _____ Vessels never previously tested or vessels with welds never previously tested are not to be approached during the step-wise increase in pressure. The pressure at which the system under test will be approached for close inspection shall be specified in the test procedure.
- _____ Personnel carrying out the test shall be provided with a safe place from which the progress of the test can be observed and controlled.
- _____ Safety clearance distances shall be reviewed by the proponent organization for each individual test, and safe clearance distances shall form part of the test procedure. Loss Prevention Department and Inspection Department shall be consulted for advice, if necessary.
- _____ Only personnel involved with the test shall be allowed near the system at any time during the test.
- _____ The test pump, if any, shall be located such that the pump operator will not be exposed to danger in the event of a failure.

5.2.6 DEPRESSURIZE SAFELY

- _____ Depressurizing valve and piping are arranged for safe discharge.
- _____ System will not be depressurized by loosening bolts or unscrewing fittings.
- _____ System is depressurized at a slow enough rate to prevent damage.
- _____ Heat exchangers are monitored with pressure gauges if necessary to prevent excessive differential pressures.

SAUDI ARABIAN OIL COMPANY (Saudi Aramco)
GENERAL INSTRUCTION MANUAL
G. I. NUMBER *Approved*

2.102

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

10/28/2008

REPLACES

08/25/2007

SUBJECT PRESSURE TESTING SAFELY

APPROVAL

HJK

PAGE NO.

18 OF 18

5.2.7 DISPOSE OF TEST MEDIUMS SAFELY

_____ Disposal procedures developed with the Environmental Protection Department and shown on the approved test procedure are followed.

5.2.8 FOLLOW ADDITIONAL SAFETY PRECAUTIONS

- _____ Temperature of the test medium is allowed to equalize with the environment to the extent practical before pressurizing.
- _____ The test pump is not left unattended during the test unless isolated with a valve.
- _____ Temporary test piping is not allowed to remain pressurized unnecessarily.
- _____ System is not allowed to remain unattended when filled with liquid unless a vent is open.
- _____ Test relief valve is not removed until the test liquid has been drained.
- _____ Test liquid is drained slowly with vents open to prevent a possible vacuum.