Chapter 14: Pressure Systems

Pressure Test Procedures

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1 Purpose

The purpose of these procedures is to ensure that pressure tests are conducted safely and effectively. They cover pressure testing of new and existing pressure systems or components at a test pressure more than 0 psig. They apply to mechanics, supervisors, inspectors, custodians, and subcontractors responsible for pressure tests.

2 Procedures

Pressure tests are performed to ensure the safety, reliability, and leak tightness of pressure systems. A pressure test is required for a new pressure system before use or an existing pressure system after repair or alteration.

There are two methods for pressure tests: hydrostatic and pneumatic. A hydrostatic test is performed by using water as the test medium, whereas a pneumatic test uses air, nitrogen, or any non-flammable and non-toxic gas. At SLAC pressure tests must be hydrostatic unless pneumatic tests can be justified.

Pressure tests must always be performed under controlled conditions, following an approved test plan, and documented in a test record. A single approved test plan may be used for several similar tests, but a separate test record is required for each.

2.1 Hydrostatic Test Procedure

Hydrostatic is the preferred method of pressure test at SLAC.

Step	Person	Action
Planning		
1.	Mechanic	Obtains test pressure after consulting the project engineer *Note: when hydrostatic test is performed on an existing pressure system, the original hydrostatic test pressure must not be exceeded.*
2.	Mechanic	Completes pressure test plan and submits for approval
3.	Supervisor	Approves plan
4.	Pressure systems program manager	Approves plan (not required for routine testing of existing systems)

Step	Person	Action
Performing		
5.	Mechanic	Ensures the pressure gauges used have current calibration stickers
6.	Mechanic	Removes all persons not directly involved with the test from the immediate test area
7.	Mechanic	Removes pressure relief valves or non-reclosing relief device from the vessel or test boundary where the test pressure will exceed the set pressure of the valve OR Holds down each valve by means of an appropriate test clamp and pressurizes both sides of non-reclosing relief devices Installs temporary, higher-rated devices where practical
8.	Mechanic	Installs the calibrated test gauge so it is visible at all times
9.	Mechanic	Ensures the skillet blanks or test plugs or clamps are appropriate for use and are free of obvious defects
10.	Mechanic	Fills and vents system as necessary to remove as much air as practical
11.	Mechanic	Ensures that water used for the test is at not less than ambient temperature, but in no case less than 70°F
12.	Mechanic	Pressurizes the system, raising the pressure in the system gradually until the designated test pressure is achieved
13.	Mechanic	Maintains this test pressure for 10 minutes before inspection. Then, if test is above maximum allowable working pressure (MAWP), reduces to MAWP while making a full thorough inspection for leaks.
14.	Mechanic	Ensures the metal temperature at the time of the hydrostatic test does not exceed 120°F
15.	Mechanic	If there is evidence of structural distortion, either rejects the system or repairs as advised by the inspector
16.	Mechanic	If there is leakage in the system, performs the following as appropriate: ▪ Ensure repairs is performed and returns to Step 12 or ▪ Rejects the system
17.	Mechanic	When the test is completed, vents the test pressure to atmosphere and returns relief devices to normal configuration
Recording		
18.	Inspector	Signs pressure test record
19.	Mechanic	Completes pressure test record and submits copy to the pressure systems program manager
20.	Mechanic	Submits copies of the test plan and test record to the custodian

2.2 Pneumatic Test Procedure

Pneumatic tests are potentially more dangerous than hydrostatic because of the higher level of potential energy. Pneumatic tests may be performed only when at least one of the following conditions exists:

- When pressure systems are so designed that they cannot be filled with water.
- When pressure systems are to be used in services where traces of the testing medium cannot be tolerated.

Using a pneumatic test instead of hydrostatic requires approval by the pressure systems program manager. In addition to a justification, a piping schematic for pneumatic pressure test is required. A recommended typical piping schematic for pneumatic test is shown in Figure 1.

Important Installation of a pressure relief valve is required for a pneumatic test.

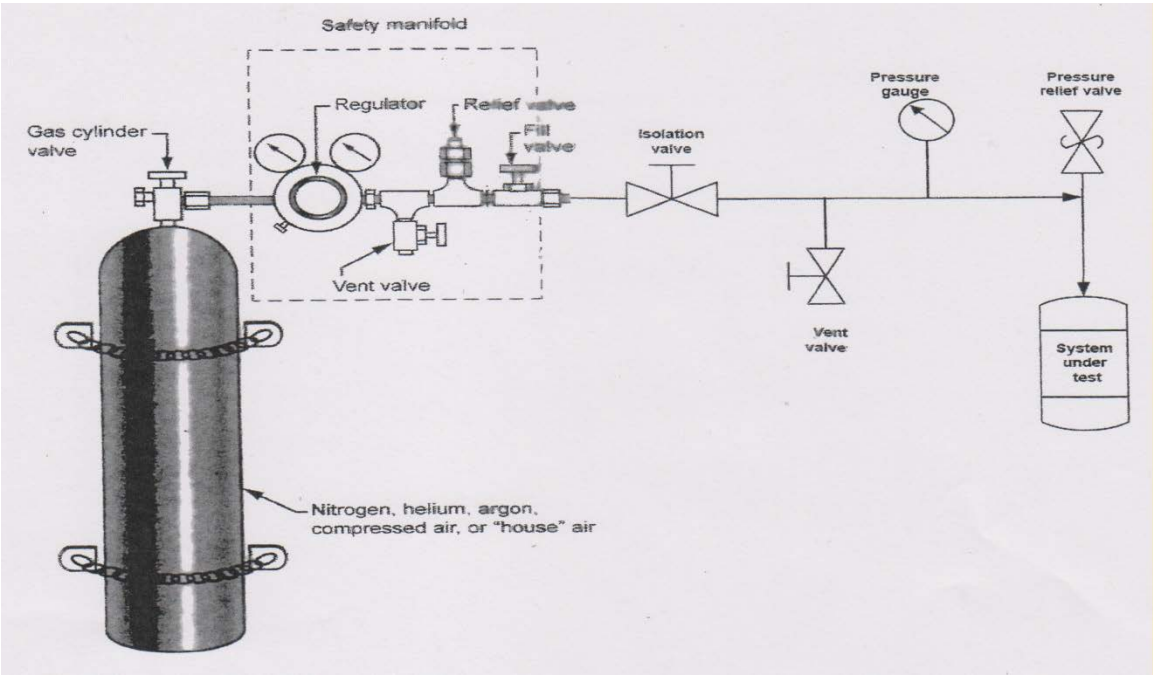

Figure 1 Recommended Typical Piping Schematic for Pneumatic Testing

Step	Person	Action
Planning		
1.	Mechanic	Obtains test pressure after consulting the project engineer *Note: ensures that the pneumatic test pressure does not exceed the established test pressure of the system, unless otherwise specified in the design documents.*
2.	Mechanic	Completes pressure test plan, including justification for pneumatic testing and a piping schematic for the test, and submits for approval
3.	Supervisor	Approves plan
4.	Pressure systems program manager	Approves plan
Performing		
5.	Mechanic	Ensures that the test gauge has a current calibration sticker. (A pressure relief valve or non-reclosing relief device may be installed in the test medium supply line to ensure that this limit is not exceeded.)
6.	Mechanic	Ensures that the test area is properly flagged, barricaded, or otherwise controlled to prevent unauthorized personnel entry
7.	Mechanic	Removes from the immediate area all persons not directly involved in the test
8.	Mechanic	Installs the calibrated test gauge so it is visible at all times
9.	Mechanic	Verifies that the pressure is continually monitored to ensure that pressure never exceeds the designated test pressure of the system
10.	Mechanic	Removes relief devices from the system to be tested, where the test pressure will exceed the set pressure of the device OR Holds down each valve disk by an appropriate test clamp and equalizes pressure on non-reclosing relief devices
11.	Mechanic	Pressurizes the system, raising pressure in the system gradually until not more than 1/2 of the test pressure is achieved
12.	Mechanic	Increases the pressure slowly in steps of approximately 1/10 of the test pressure until the required test pressure has been reached
13.	Mechanic	Reduces the pressure to the maximum operating pressure before proceeding with the inspection; holds the pressure for a sufficient period of time to permit inspection of the system
14.	Mechanic	Checks the pressure gauge periodically for indications of leakage
15.	Mechanic	Applies a soap solution to accessible welds, screwed pipe joints, flanges, et cetera where leakage is suspected
16.	Mechanic	If there is evidence of structural distortion, either rejects the system or repairs as advised by the inspector
17.	Mechanic	If there is leakage in the system, performs the following as appropriate: ▪ Ensures repair is performed and return to Step 11 or

Step	Person	Action
		▪ Rejects the system
18.	Mechanic	When the test is completed, vents the test medium to approved discharge vicinity/atmosphere
Recording		
19.	Inspector	Signs pressure test record
20.	Mechanic	Completes pressure test record and submits copy to the pressure systems program manager
21.	Mechanic	Submits copies of the test plan and test record to the custodian

2.3 Test Pressure

There are many types of pressure systems designed under American Society of Mechanical Engineers (ASME) code, and repaired under the *National Board Inspection Code (NBIC)*. The test pressure of various pressure systems must be calculated based on following.

Table 1 Test Pressures for New Pressure Vessel and Piping Systems

System	Code	Hydrostatic	Pneumatic
Boiler – power	ASME Section I	1.5 × MAWP	Not permitted
Boiler – heating	ASME Section IV	1.5 × MAWP	Not permitted
Pressure vessel	ASME Section VIII		
	Division 1	1.3 × MAWP	1.1 × MAWP
	Division 2	1.43 × MAWP	1.15 × MAWP
Power piping	ASME Section B31.1	1.5 × design pressure	1.2 × design pressure
Process piping	ASME Section B31.3	1.5 × design pressure	1.1 × design pressure
Building services piping	ASME Section B31.9	1.5 × design pressure	1.25 × design pressure
Sprinkler system	NFPA 13	200 psi	40 psi

Table 2 Test Pressures for Existing Pressure Vessel and Piping Systems

Type of Work	Code	Hydrostatic	Pneumatic
Inspection	NBIC	0.9 × SV setting	Agreement between owner and inspector
Alteration	NBIC	1.5 × MAWP	According to original code of construction
Repair	NBIC	1.5 × MAWP	Minimum pressure required verifying leak tightness

Notes:
NBIC: National Board Inspection Code
MAWP: maximum allowable working pressure
SV: safety valve

3 Forms

The following forms are required by this procedure:

- Pressure Systems: Pressure Test Plan Form (SLAC-I-730-0A21J-044). A detailed pressure test plan is required for every pressure test conducted at the laboratory. An approved plan may be used for several similar tests.
- Pressure Systems: Pressure Test Record Form (SLAC-I-730-0A21J-045). A separate test record is required for each pressure test.

4 Recordkeeping

The following recordkeeping requirements apply for this procedure:

- The custodian of a given pressure system must maintain copies of test plans and records for five years.
- The pressure systems program manager maintains copies of all pressure test plans and records, permanently.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 14, "Pressure Systems"
  - Pressure Systems: Installation, Inspection, Maintenance, and Repair Requirements (SLAC-I-730-0A21S-053)
- Chapter 51, "Control of Hazardous Energy"

Other SLAC Documents

- Pressure Systems Safety Program (SharePoint)

Other Documents

- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC), 2015 (ASME BPVC-2015)
- ASME Pressure Piping Code, including applicable addenda and code cases
  - ASME B31.1-2014, “Power Piping” (ASME B31.1-2014)
  - ASME B31.3-2014, “Process Piping” (ASME B31.3-2014)
  - ASME B31.9-2014, “Building Services Piping” (ASME B31.9-2014)
- National Board of Boiler and Pressure Vessel Inspectors (NBBI)
  - NB 23-2015, *National Board Inspection Code (NBIC)* (NBBI NB 23-2015)