

Chapter 14: [Pressure Systems](#)

Installation, Inspection, Maintenance, and Repair Requirements

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URL: <http://www-group.slac.stanford.edu/esh/eshmanual/references/pressureReqInspectMaintRepair.pdf>

1 Purpose

The purpose of these requirements is to maintain the mechanical integrity of pressure systems throughout their life. They cover installation, inspection, maintenance, and repair of all types of pressure systems. They apply to equipment owners, custodians, inspectors, mechanics, and installation and repair organizations.

2 Requirements

The following are minimum requirements. Systems that present higher risk because of use history, unusual ambient operating temperature and pressure, or special materials or system content may require special installation, inspection, maintenance, and/or repair.

2.1 Installation

A manufacturer, supplier, or mechanical subcontractor may install a pressure system. The installer must follow the design documentation, quality assurance, code requirements, and manufacturer's recommendations. The installer is responsible for pressure testing, installation inspection, performance testing, and acceptance testing.

- Installation must be performed by qualified personnel of the manufacturer or mechanical subcontractor or a SLAC pressure system mechanic.
- After installation is complete, a pressure test must be performed and documented. The pressure test plans must be submitted to the pressure systems program manager before performing the pressure test.
- All installation and pressure test records must be submitted to the pressure systems manager.

Note *The National Board Inspection Code (NBIC), Part I, "Installation", may be followed as a guideline for installation.*

2.2 Inspection

- Inspections will be performed only by pressure system inspectors, designated by line management and trained and qualified by the pressure systems program manager.
- Inspectors will follow one or a combination of the following for performing inspections:

- *National Board Inspection Code (NBIC)*
- International Code Council (ICC) code
- American Petroleum Institute (API) code
- Compressed Gas Association (CGA) code
- Manufacturer's recommendations

2.2.1 Types

The two pressure system inspection types are external and internal.

An external inspection is conducted while the system is operating and includes

- Examination of system components, including structural attachments, vessel connections, inlet piping, outlet piping, drain piping, piping supports, and appurtenances
- Identifying evidence of leakage or inadequate insulation or other coverings

An internal inspection is conducted once the pressure has been released and the system is open for inspection. It includes inspecting for corrosion and wear around

- Welded seams, nozzles, and areas adjacent to welds
- Vessel connections
- External fittings or controls

2.2.2 Frequency

Minimum inspection intervals for pressure systems are listed in Table 1. Certain systems require more frequent inspection because of higher hazard potential.

Important If any system shows signs of wear or a defect, steps must be taken immediately to address the problem. See Sections 2.3 and 2.4 for maintenance or repair requirements.

Table 1 Pressure System Inspection Frequency

Equipment	Inspection Type	Inspection Frequency
Heating boiler	External	3 years
Pressure vessel, corrosive service	External and internal	2 years
Pressure vessel, non-corrosive service	External	3 years
Vacuum vessel	External	5 years

2.2.3 Pressure Test

A pressure test is required for a new pressure system or an existing pressure system after repair or alteration (see [Pressure Systems: Pressure Test Procedures](#)).

Pressure systems or system components designed under federal Department of Transportation (DOT) requirements ([49 CFR 178](#)) require hydrostatic pressure tests to ensure mechanical integrity over a period of time. Minimum hydrostatic test frequencies for such DOT systems are listed in Table 2.

Table 2 Hydrostatic Test Frequency and Pressure

Pressure System	Test Frequency	Test Pressure
Tube trailer	5 years	5/3 times service pressure
Compressed gas cylinder	5 years	5/3 times service pressure

2.2.4 Leak Test and Mechanical Integrity for Vacuum Systems

A vacuum system/vacuum component must be leak tested to determine conformance with the maximum permissible leak specified on the drawing, purchase order, or other documents supplied at the order. The mechanical integrity assessment is looking for evidence of vacuum vessel instability or buckling.

[Leak Test and Mechanical Integrity Standard](#) (SLAC-I-020-203-001-00) identifies a standardized approach for helium leak detection, which takes into account the specified target leak rate, the volume of the system, and the detector/system pump capacity.

2.2.5 Pressure Relief Devices

Pressure relief devices such as safety valves, pressure relief valves, and rupture disks prevent a system from becoming over pressurized. Their proper function is essential. Pressure relief devices must be inspected according to the frequency listed in Table 3. The inspection should verify that

- The device is appropriate to current use
- The set pressure is correct
- The installation is correct and the device functions while system is in operation (test as appropriate)

Defective device(s) must be replaced immediately.

Table 3 Pressure Relief Device Inspection Frequency

Equipment	Inspection Frequency
Heating boiler	3 years
Pressure vessel, corrosive service	2 years
Pressure vessel, non-corrosive service	3 years
Vacuum vessel	5 years

Pressure relief valves are required to be tested and set pressures adjusted when

- The valves are not relieving pressure at designated set pressure,
- The valves are leaking, or

- When recommended by the pressure system inspector

A pressure system that includes an American Society of Mechanical Engineers (ASME) code designed vessel must be equipped with ASME-rated pressure relief devices. It is recommended that ASME-rated pressure relief devices also be used on non-ASME pressure systems of more than 15 psig working pressure.

ASME-rated pressure relief devices bear the following certification mark and designators:



- UV pressure relief valve for pressure vessels
- UD rupture disk for pressure vessels
- HV pressure relief valve for heating boilers

2.2.6 Recordkeeping

All inspections must be recorded using [Pressure Systems: Inspection Report Form](#). For additional recordkeeping requirements, see Section 4.

2.3 Maintenance

2.3.1 Types

Pressure systems must be maintained according to a schedule appropriate to system type and the operating conditions. Maintenance types include

- Preventive, which is generally determined by the manufacturer
- Break down, which is an opportunity for maintenance due to unforeseen equipment shutdown
- Periodic, which is required maintenance as determined by manufacturer's recommendation and/or SLAC policy

Maintenance includes replacement or repair of defective or worn components. Maintenance does not include implementing modifications or alterations.

2.3.2 Qualifications

Maintenance must be performed by a qualified mechanic.

Note All work involving hazardous energy must adhere to requirements in [Chapter 51, "Control of Hazardous Energy"](#)

2.3.3 Compressed Gas Systems

2.3.3.1 Before First Use

Before a compressed gas system is used the first time:

- Make sure the system is equipped with the correct *regulator*. Never force connections that do not fit. An improper fit may indicate that the regulator or connector is not suitable.
- Inspect the regulator and valves and remove any grease, oil, dirt, or solvent. Never use grease or oil to lubricate regulators or valves – compressed gas and volatile lubricants can cause an explosion.
- Only use wrenches or tools provided or recommended by the supplier to open or close a valve; never use pliers.
- Place the cylinder so that it is easily accessible, does not become part of an electric circuit, and does not become entangled in experimental apparatus.
- Equip the system discharge lines with approved check valves when connected to a closed system. This prevents inadvertent backflow contamination of cylinders.

2.3.3.2 General Use Requirements

- Keep valve protection caps in place until ready to use.
- Close the valve when equipment is not in use.
- Use the cylinder valve, not the regulator, for turning off the gas.
- Close the cylinder valve and release all pressure before removing the regulator.
- Never heat cylinder – even when partially empty – with any device that could raise the surface temperature of the cylinder to above 125° F.
- Keep the cylinder clear of all electrical circuits, flame, and sparks.

2.3.3.3 Upright and Inverted Use

- System containing flammable liquefied gas (for example, acetylene) must be used valve end up, except those designed for use in a horizontal position and those cylinders containing non-liquefied gases.
- When used upright (inclined no more than 45 degrees from the vertical), the relief device must always in direct communication with the gas phase.
- If inverted, the cylinder must be secured and the dispensing apparatus must be specifically designed for inverted use.

2.3.4 Recordkeeping

All maintenance must be recorded using [Pressure Systems: Maintenance and Repair Report Form](#). In addition, if a maintenance procedure includes pressure testing as required by code, a record of the test must be submitted to the pressure systems program manager.

2.4 Repair

Repair can take the form of restoring a non-functioning system to approved design specifications or it can include system modification or alteration (which is also referred to as *re-rating*).

The following requirements apply:

- All repairs that restore a system to the formerly approved design specification must be done in accordance with the code of construction, which must be in compliance with ASME code, the *National Board Inspection Code (NBIC)*, national standards, or other approved codes as listed in the Pressure Systems Design Manual (forthcoming).
- If a system is to be modified or altered, the new design specifications must be verified by engineering calculations and approved by the pressure systems program manager.
- Modifications must be performed by qualified personnel as follows
 - Repairs that require welding to ASME code stamped vessels (“U”, “UM”, “H”, et cetera) must be performed by an organization holding an “R” stamp.¹
 - Alterations must be performed by an organization holding an “R” stamp.
 - Repairs to pressure relief or pressure safety valves with the ASME code “V”, or “UV” stamps must be performed by an organization holding a “VR” stamp.
 - All other repairs must be performed by a *qualified mechanic*.
- Completion of repairs and alterations must be verified by inspection and testing as defined by applicable ASME *Boiler and Pressure Vessel Code (BPVC)*, ASME *Pressure Piping Code*, and *National Board Inspection Code (NBIC)*.

2.4.1 Recordkeeping

All repairs must be recorded using [Pressure Systems: Maintenance and Repair Report](#). In addition, the repair organization (vendor) must complete and submit the following for any work performed on ASME-coded systems:

- For repairs: [National Board Form R-1](#). Supplied by qualified vendor to custodian, who submits a copy to pressure systems program manager
- For alterations: [National Board Form R-2](#). Supplied by qualified vendor to custodian, who submits a copy to pressure systems program manager

3 Forms

The following are forms required by these requirements:

- [Pressure Systems: Maintenance and Repair Report Form](#) (SLAC-I-730-0A21J-042). Record of required maintenance and repair work
- [Pressure Systems: Inspection Report Form](#) (SLAC-I-730-0A21J-043). Record of required inspection

1 The National Board of Boiler and Pressure Vessel inspector issues stamps the “R” and “VR” stamps.

- [National Board Form R-1](#)
- [National Board Form R-2](#)
- [Pressure Systems Database](#)

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- Inspection
 - Custodian maintains completed inspection report forms, keeping a copy of record for five years and also forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database
- Maintenance
 - Custodian maintains completed maintenance and repair report forms, keeping a copy of record for five years and also forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database
 - If maintenance procedures include pressure testing as required by code, a record of the test must be submitted to the pressure systems program manager
- Repair
 - Custodian maintains completed maintenance and repair report forms, keeping a copy of record for five years and forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database
 - Qualified vendor supplies completed National Board Form R-1 (repairs) or National Board Form R-2 (alterations) to custodian, who submits a copy to pressure systems program manager

Note Always submit records to the pressure safety program manager before discarding if the record is older than the required five-year period.

5 References

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

- [Chapter 14, “Pressure Systems”](#)
 - [Pressure Systems: Pressure Test Procedures](#) (SLAC-I-730-0A21C-033)
- [Chapter 51, “Control of Hazardous Energy”](#)

Other SLAC Documents

- [Pressure Systems Safety Program](#) (SharePoint)
- Pressure System Design Manual (forthcoming)
- [Leak Test and Mechanical Integrity Standard](#) (SLAC-I-020-203-001-00)

Other Documents

- Title 49, *Code of Federal Regulations*, “Transportation”, Subtitle B, “Other Regulations Relating to Transportation”, Chapter 1, “Pipeline and Hazardous Materials Safety Administration, Department of Transportation”, Subchapter C, “Hazardous Materials Regulations”,
 - Part 173, “Shippers – General Requirements for Shipments and Packagings” ([49 CFR 173](#))
 - Part 178, “Specifications for Packagings” ([49 CFR 178](#))
 - Part 180, “Continuing Qualification and Maintenance of Packagings” ([49 CFR 180](#))
- 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
- National Board of Boiler and Pressure Vessel Inspectors (NBBI) NB 23-2015, *National Board Inspection Code (NBIC)* (NBBI NB 23 -2015)