Document Level:	Functional Series
Document Number:	**Criterion 419 R1**
Approval Date:	09/02/2010
Effective Date:	10/01/2010
Supersedes:	Criterion 419 R0

CONDUCT OF MAINTENANCE (P950)

OPERATIONS AND MAINTENANCE MANUAL
OPERATIONS & MAINTENANCE CRITERION

TITLE: INSPECTIONS AND TESTING OF PRESSURE VESSELS AND PRESSURE RELIEF VALVES

Name	Organization	Date	Signature
Criterion Author:			
Charles DuPré Chief Pressure Safety Officer	ES-DE	08/31/10	Signature on File (mm)
Approved by:			
Dan Steinberg ES Division Leader	ES-DO	09/01/10	Signature on File (mm)
Charles Anderson NHHO Deputy Associate Director	ADNNHO	09/01/10	Signature on File (mm)
Issuing Authority:			
Susanne Waylett MSS Division Leader	MSS-DO	09/02/10	Signature on File (mm)

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RECORD OF REVISIONS

Revision No.	Date	Description
0	4/04/03	Initial Issue
1	8/18/2010	This revision includes the incorporation of all formatting changes addressed in Revision 3 of the O&M Criterion 101 Writer's Guide. This revision reflects current organizational structure and responsibilities, corrections, clarifications and examples This revision incorporates maintenance requirements from the LANL Engineering Standards Manual, Chapter 17.

TABLE OF CONTENTS

CRITERION 419

INSPECTIONS AND TESTING OF PRESSURE VESSELS AND PRESSURE RELIEF VALVES

1.0 PURPOSE

The purpose of this Criterion is to establish the minimum requirements and best practices for operation, inspection, and testing of commercial pressure vessels and relief devices on systems supporting LANL facilities. Non-commercial pressure systems are addressed by P 101-34 Pressure, Vacuum and Cryogenic Systems.

This document addresses the requirements of P 315, *Conduct of Operations Manual*, and P 950, *Conduct of Maintenance*, by defining the minimum operations and maintenance criteria for structures, systems, and components that it covers. This Criterion lists requirements that are based on codes, standards, contract commitments, lessons learned, or business case. It also lists recommendations based on industry practices, operational experience, or business case. Guidance for implementation of the requirements and recommendations is also provided.

2.0 SCOPE

The scope of this Criterion includes the operation, inspection, testing, and preventive and predictive maintenance of facility-related pressure vessels and pressure relief devices at all nuclear and non-nuclear LANL facilities. Equipment addressed by this Criterion includes air receivers, heat exchangers, expansion tanks, steam and hot water heating boilers, electric, gas water heaters and pressure piping.

Relief devices, (including pressure relief valves, pressure safety valves, relief valves, rupture discs, and safety valves) associated with the above-mentioned equipment or other facility equipment such as chillers, cryogenic tanks are also included in the scope of this document. Department of Transportation (DOT) compressed gas cylinders and containers are not in the scope of this Criterion.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

AHJ	Authority Having Jurisdiction
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CMMS	Computerized Maintenance Management System
CPSO	Chief Pressure Safety Officer
DL	Division Leader

DMAPS	Data Management and Analysis for Process Systems
DOE	Department of Energy
DOT	Department of Transportation
DSA	Documented Safety Analysis
ESM	Engineering Standards Manual
FOD	Facility Operations Director
FWO	Facility and Waste Operations
IBC	International Building Code
IHS	Industrial Hygiene & Safety
LANL	Los Alamos National Laboratory
MAWP	Maximum Allowable Working Pressure
ML	Management Level
MM	Maintenance Manager
MOP	Maximum Operating Pressure
MSS	Maintenance and Site Services
NBIC	National Board Inspection Code
NDT	Nondestructive Testing
NMAC	New Mexico Administrative Code
O&M	Operations and Maintenance
OM	Operations Manager
PMI	Preventive Maintenance Instruction
POC	Point of Contact
PPE	Personal Protective Equipment
PSO	Pressure Safety Officer
SSC	Structures, Systems, and Components
TSR	Technical Safety Requirements
UMC	Uniform Mechanical Code

3.2 Definitions

ASME Code- The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code establishes Recommended Rules for the Care and Operation of Heating Boilers and also establishes the Rules of Safety governing the Design, Fabrication and Inspection during construction of Boilers and Pressure Vessels.

Boiler- A closed vessel used for heating water or for generating steam by direct application of heat from combustible fuels or electricity.

Corrosive Fluids- Substances that cause corrosion.

High Pressure Steam Boiler- A boiler in which steam or other vapor is generated at pressures exceeding 15 psi.

Low-Pressure Hot-Water Heating Boiler- A boiler in which water is heated for the purpose of supplying heat at pressures not exceeding 160 psi and temperatures not exceeding 250 degrees F.

Management Level (ML1, ML2, ML3, ML4)- ML designation is used to grade the structures, systems, equipment, and components and associated activities based on their importance to the protection of the public, environment, and workers, security, and the Laboratory mission. See AP-341-502, *Management Level Determination* for definitions of each ML level.

National Board Inspection Code (NBIC)- It is the purpose of the National Board Inspection Code to maintain the integrity of pressure vessels and pressure retaining devices after they have been placed into service. The code does this by providing rules and guidelines for inspection after installation, repair, alteration or re-rating, thereby helping to ensure that these objects may continue to be safely used.

Nondestructive Testing (NDT)- Any testing method which does not involve damaging or destroying the test sample; including the use of x-rays, ultrasonics, radiography, magnetic flux, and so on.

Owner-User (Inspection Organization)- An owner or user of pressure retaining items that maintains an established inspection program, whose organization and inspection procedures meet the requirements of the National Board rules and are acceptable to the jurisdiction or jurisdictional authority wherein the owner is located.

Pressure Vessel- A container designed and built to hold pressurized fluids. See ASME Section VIII, Divisions 1, 2, and 3.

Remaining Life- Period of service time based on corrosion rates and conditions of service. See NBIC RB-3236.

4.0 RESPONSIBILITIES

4.1 MSS-Division Leader (MSS-DL)

The Maintenance and Site Services (MSS) Division Leader (DL) receives and approves or rejects, in conjunction with the Authority Having Jurisdiction (AHJ), requests for variances from this Criterion. Maintains the record of decision for all variance requests.

4.2 MSS- Maintenance Programs (MSS-MP)

Responsible for the administrative content, and for monitoring applicability and implementation status of this Criterion. MSS-MP will assist organizations that are not applying or meeting the implementation expectations contained herein or will elevate their concerns to the appropriate level of LANL management.

4.3 Engineering Services Division (ES)

ES is responsible for the technical content of this Criterion and assessing the proper implementation across the Laboratory.

ES shall provide technical assistance to support implementation of this Criterion.

4.4 Facility Operations Director (FOD)

Responsible for implementation of this O&M Criterion for identified systems/equipment within their facility boundaries.

4.5 Operations Manager (OM)

Responsible to the FOD for implementing operation portions of this Criterion and for coordinating transfer of systems/equipment to the Maintenance Manager for maintenance activities. The OM with concurrence of the FOD will prioritize implementation within budget allocations and submit variances as necessary.

4.6 Maintenance Manager (MM)

Responsible to the FOD and the MSS-Division Leader for implementing the maintenance portions of this Criterion and for coordinating the transfer of systems/equipment to the Operations Manager at the conclusion of maintenance activities. The MM with concurrence of the FOD will prioritize implementation within budget allocations and submit variances as necessary.

4.7 Authority Having Jurisdiction (AHJ)

The AHJ is the LANL Site Chief Engineer, who is responsible for providing a decision on specific technical questions regarding the systems or equipment relevant to this criterion.

The LANL Site Chief Engineer in conjunction with the MSS Division Leader is the approval authority for all exceptions and variances to this Criterion.

4.8 Chief Pressure Safety Officer (CPSO)

Responsible for the technical content of this Criterion and monitoring the proper implementation across the Laboratory. The CSPO provides technical assistance to support implementation of this Criterion and will assist organizations that are not applying or meeting implementation expectations of this Criterion or will elevate concerns to the appropriate level of LANL management.

Also serves as Point of Contact for Chapter 17 of the LANL Engineering Standards Manual (ESM) and is responsible for the coordination of requirements between this Criterion and ESM Chapter 17. Reviews exception and variance requests as submitted by the Site Chief Engineer.

4.9 Pressure Safety Officer (PSO)

In addition to responsibilities defined in the ESM Chapter 17, aids system owners in compliance with the requirements of this Criterion.

4.10 Pressure System owner

Responsible for the overall operation, maintenance, design (code compliance), documentation, and/or construction of a pressure system

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. However, all applicable precautions should be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards and precautions that may not be immediately obvious.

5.1.1 Clean Threads

Before installing a new relief device it is recommended that a pipe tap be used to assure clean cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.

5.1.2 Overtightening

Avoid over tightening as this can distort the relief device seats.

5.1.3 Necessary Operation Only

Avoid excessive "popping" of the relief device as even one opening can result in leakage. Relief devices should be operated only often enough to assure that they are in good working order.

Note: Safety valves should only be operated as specified in National Boiler Inspection Code. There is now approved equipment that can check that the valve will open at its set pressure without full exercising of the valve. This avoids premature cutting of the valve seat. This service is available from an ASME approved repair shop with stamp authority.

5.1.4 Vertical Pull

Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the relief device.

5.1.5 Pressure Differential

Avoid having the operating pressure too near the relief device set pressure. A minimum differential of 5 psi. or 10% (whichever is greater) is recommended. When possible, an even greater differential is desirable to assure better seat tightness and valve longevity.

5.1.6 Discharge Pipe Support

Relief devices should not support the weight of discharge piping. Even when discharge piping is supported separately, temperature changes can cause strain. Drip pan elbows or flexible connections shall be used to prevent strain on relief devices.

5.1.7 Pipe Compound

Apply only a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage. Flanged connections should be clean and straight, with new gaskets. Draw the mounting bolts down evenly and torque to the proper value. See ESM Chapter 17 for torque value guidance.

5.1.8 Hand Operation

Do not operate by hand a relief device with less than 75% of the stamped set pressure exerted on the underside of the disc. When operating by hand, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

5.1.9 Inspection Under Pressure

Since much of inspection work is accomplished while the vessel is in operation and under pressure, utmost caution is advised when working around pressurized vessels.

5.1.10 Inspection Temperature

When preparing a pressure vessel for internal inspection that normally operates at high temperature or low temperature (below –20°F or 7°C) the vessel shall be allowed to cool or warm at a rate low enough to avoid damage to vessel.

5.1.11 Lockout/Tagout

Adhere to all lockout/tagout requirements to assure that connections to vessels (including drain lines) are isolated.

5.1.12 Confined Space

Pressure vessel internal inspections may require entry to confined spaces. Contact IHS for assistance with entry requirements and determination of appropriate personal protective equipment.

5.1.13 Leakage

Do not try to stop leakage on over pressure-relieving devices by tightening the spring or by blocking it in any manner whatsoever.

5.1.14 Discharge Safety

Never look into discharge of any type of safety device while the system is pressurized.

5.1.15 Valve Actuation

Never use a hammer or tool of any kind to rap on a relief device. Always use the try lever or pull ring to open the valve and always let the valve snap shut.

5.1.16 Discharge Piping

Any changes or modifications to relief device discharge piping must be done in accordance with the Engineering Change Notice (AP-341-506) or Design Change Package (AP-341-505) process.

5.2 Limitations

The intent of this Criterion is to identify the minimum requirements and recommendations for structures, systems, and components (SSCs) operation and maintenance across the Laboratory. Each Criterion user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, manufacturer O&M requirements and guidance, etc.) Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities should implement the requirements of DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities* as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or the Code of Federal Regulations (CFR) as applicable.
Nuclear facilities, certain high hazard facilities and explosives facilities may have additional facility specific requirements beyond those presented in this Criterion which are contained in the Documented Safety Analysis (DSA), Technical Safety Requirements (TSRs), or facility safety plans, as applicable.

6.0 REQUIREMENTS

Minimum requirements for all users are specified in this section. Requested variances to these requirements shall be prepared and submitted to MSS-MP and the LANL Site Chief Engineer for review and approval. The MSS Division Leader in conjunction with the LANL Site Chief Engineer approves or denies variances. Variances cannot conflict with a safety basis or TSR.

The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgment, safety matters, and operations and maintenance experience drive the requirements contained in this section.

Note: Discovery of SSC with a degraded or non-conforming condition in nuclear, high hazard, or moderate hazard facilities is a triggering input to the Operability Determination and Functional Assessment process defined in AP-341-516,

Operability Determination and Functionality Assessment. Degraded or non-conforming conditions include, but are not limited to, failed equipment or components, unsatisfactory readings, code or standard violations and fire protection impairments. Personnel performing tests or inspections under this O&M Criterion are not responsible nor authorized to perform the Operability Determination. Any degraded or non-conforming condition discovered under this O&M Criterion shall be communicated to the FOD Representative for input to the AP-341-516 process. While that process may not apply in Low Hazard Non-Nuclear and Office facilities, the same concept applies. The FOD organization is responsible to determine the response (taking equipment out of service, establishing fire watches, limiting operations, etc.) to SSC degraded and non-conforming conditions.

6.1 Operations Requirements

6.1.1 Pressure Systems

Pressure Vessels must operate at or below the Maximum Operating Pressure (MOP) and within its design temperature limits. The MOP is generally 10-20% below the Maximum Allowable Working Pressure (MAWP), which is the pressure at which pressure relief devices are set to open. Operating above the design temperature can lower the strength of the pressure system material, thereby actually lowering the MAWP and MOP. Operating below the design temperature can, in some materials, decrease ductility of the pressure system material, which increases the chance of failure due to local stress concentrations. Engineering review and approval are required to operate a system above or below the design temperature.

Basis: P101-34, *Pressure, Vacuum and Cryogenic Systems.*

6.2 Maintenance Requirements

6.2.1 Non-Fired Pressure Vessel Inspections by Type and Frequency

Use the following tables for determining the inspection intervals for pressure vessels, relief devices, and piping. Perform inspections in accordance with ITM-342-1701, *Pressure Vessel Inspection and Test*, using CPSO approved organization(s) like, for example, QA-PM.

Basis: Frequencies documented in EM Ref-59.

Table 1

Service	External & Wall Thickness (Ultrasonic) Inspection Interval in Years	Internal Inspection Interval in Year
Corrosive Service	3	5
Non-corrosive Service	5[1]	10[2]

[1] The requirement for wall thickness measurement of vessels in non-corrosive service may be waived if inspection data indicates no wall thinning is occurring.

[2] Except where API 510 or NBIC allows on-stream [external and wall thickness] inspection in lieu of internal inspection. Excerpt from API 510-2006 Para 6.5.2.1): At the discretion of the inspector, an [external and wall thickness] inspection may be substituted for the internal inspection in the following situations:

a. When size or configuration makes vessel entry for internal inspection physically impossible.
b. When vessel entry for internal inspection is physically possible and all of the following conditions are met:
    1. The general corrosion rate of a vessel is known to be less than 0.005 in. (0.125 mm) per year.
    2. The vessel remaining life is greater than 10 years.
    3. The corrosive character of the contents, including the effect of trace components, has been established by at least five years of the same or similar service.
    4. No questionable condition is discovered during the external inspection.
    5. The operating temperature of the steel vessel shell does not exceed the lower temperature limits for the creep-rupture range of the vessel material.
    6. The vessel is not subject to environmental cracking or hydrogen damage from the fluid being handled.
    7. The vessel does not have a non-integrally bonded liner such as strip lining or plate lining.

Note: NBIC-23 states in Section RB-3237 that the maximum period between internal inspections or a complete on-stream evaluation of pressure vessels shall not exceed ½ of the estimated remaining life of the vessel or 10 years, whichever is less. When the remaining operating life is less than 4 years, the inspection interval may be the full remaining safe operating life up to a maximum of 2 years.

6.2.1.1 <u>Pressure Vessels Exempt from Mandatory Periodic Test/Inspection</u>

Table 2 below is from PD342, Engineering Standards Manual, Chapter 17, section 1, table 13-1.

Table 2

Vessels listed as exempt from the scope of ASME Section VIII, Division 1. Excerpts:

U-1(f) a vessel for containing water[1] under pressure, including those containing air the compression of which serves only as a cushion, when none of the following limitations are exceeded:

(1) a design pressure of 300 psi (2 MPa);

(2) a design temperature of 210°F (99°C);

(g) a hot water supply storage tank heated by steam or any other indirect means when none of the following limitations is exceeded:

(1) a heat input of 200,000 Btu/hr (58.6 kW);

(2) a water temperature of 210°F (99°C);

(3) a nominal water containing capacity of 120 gal (450 L);

(h) vessels not exceeding the design pressure…at the top of the vessel, limitations below, with no limitation on size [see UG-28(f), 9-1(c)]:

(1) vessels having an internal or external pressure not exceeding 15 psi (100 kPa);

(2) combination units having an internal or external pressure in each chamber not exceeding 15 psi (100 kPa) and differential pressure on the common elements not exceeding 15 psi (100 kPa) [see UG-19(a)];

(i) vessels having an inside diameter, width, height, or cross section diagonal not exceeding 6 in. (152 mm), with no limitation on length of vessel or pressure;

(j) pressure vessels for human occupancy.[2]

U-1(j) Pressure vessels exclusive of those covered in U-1(c), U-1(g), U-1(h), and U-1(i) that are not required by the rules of this Division to be fully radiographed, which are not provided with quick actuating closures (see UG-35), and that do not exceed the following volume and pressure limits may be exempted from inspection by Inspectors, as defined in UG-91, provided that they comply in all other respects with the requirements of this Division:

(1) 5 cu ft (0.14 m3) in volume and 250 psi (1.7 MPa) design pressure; or

(2) 3 cu ft (0.08 m3) in volume and 350 psi (2.4 MPa) design pressure;

(3) 11.2 cu ft (0.04 m3) in volume and 600 psi (4.1 MPa) design pressure.

Note: Exemption must not be used if corrosion is anticipated or detected

[1]The water may contain additives provided the flash point of the aqueous solution at atmospheric pressure is 185°F or higher. The flash point must be determined by the methods specified in ASTM D 93 or in ASTM D 56, whichever is appropriate

[2]Requirements for pressure vessels for human occupancy are covered by ASME PVHO-1

Basis: API 510-2006, *Pressure Vessel Inspection Code: Inspection, Rating, Repair, and Alteration,* App A on exempted systems, with Section VIII Div 1 (pp 2-3, 2007) wording substituted for API's paraphrasing. PSO may choose to require inspection regardless of any exemption.

6.2.2 Boiler Inspection by Type and Frequency

Table 3

DeviceType	Internal Inspection Frequency[1]	External Inspection Frequency
High-Pressure Boilers and High-Pressure Steam Generators	Annually[2]	Annually[3]
Direct Fire Steam Jacketed Kettles	Every 24 months[2]	Every 24 months[3]
Low-Pressure Steam Boilers	Every 24 months[2]	Every 24 months[3]
Low-Pressure Hot Water Heating	Every 24 months[2]	Every 24 months[3]

[1] A certificate of inspection may be issued with an external inspection; however, an internal inspection must be made within six months of the external inspection

[2] When the construction does not permit an internal inspection, one external inspection annually is required.

[3] External inspection may lead to an internal inspection or shut down if deficiencies are found. Internal inspection is also required following modification of pressure retaining components.

Basis: The above inspection frequency is required per the New Mexico Administrative Code (NMAC) 14.9.4.25, *Inspections Methods and Frequencies.*

6.2.3 Pressure Vessel External Inspection

Note: The inspections described in this section shall be performed by a National Board Commissioned Inspector, by an inspector holding a valid owner-user inspection commission issued by the National Board of Boiler and Pressure Vessel Inspectors, or by an American Petroleum Institute (API) certified inspector. Perform external inspections as per NBIC-23 Section RB-3231.

6.2.3.1 Pre-Inspection Activities

1. Review safety valve test certificates and test dates on all safety valves if certificate is not available, call stamp holding company and request a certificate copy for all safety valves to be kept on file with boiler inspection certificates.
2. Review operating conditions against vessel rating.
3. Review normal contents of the vessel.
4. Review date of last inspection.
5. Review current inspection permit.
6. Review ASME Code Symbol Stamping or mark of code construction.
7. Review National Board registration number.
8. Review records of wall thickness checks, especially on vessels where corrosion is a consideration.

Basis: The above pre-inspection requirements are based NBIC-23 Section RB-3220, National Board Inspection Code. NBIC-23 is the nationally recognized code containing inspection criteria for ASME pressure vessels. API 579, 580, 581, 510, 572, 573, 574 and 576 are also referenced in P 101-34 as a requirements basis.

6.2.3.2 Pressure Vessel External Inspection Steps

1. Review name plate data from pressure vessel.
2. Review the working pressure of the vessel.
3. Review nameplate marking or stamping of the vessel pressure relief device(s). It should be compared to stamping on the pressure vessel. The set pressure shall be no higher than the MAWP marked on the pressure vessel.
4. Verify nameplate capacity and if possible, compare to system capacity requirements
5. Visually inspect the vessel for damage, modifications, welds, etc. to validate vessel integrity.
6. Fill out inspection report form.
7. Out-brief owner of vessel.
8. Issue certificate of code inspection compliance.

Basis: These steps were followed by National Board Commissioned Inspectors during past external inspections performed on LANL pressure vessels.

Note: The vessel external inspection may occur while the vessel is on stream, but may lead to internal inspection or shutdown if deficiencies are found. The inspector may use a variety of non-destructive testing methods including visual examination, ultrasonic thickness testing, liquid penetrant testing, magnetic particle testing, or radiography depending upon field conditions.

6.2.3.3 Inspection of Gauges

During pressure vessel external inspection, the pressure indicated by the required gauge should be compared with other gauges on the same system. Gauges must have a current calibration date. When required, (due to apparent gauge damage, indicator hunting, vibrating, damping fluid contamination,) compare the pressure indicated by the operating pressure gauge with a calibrated standard test gauge.

Basis: NBIC-23 Section RB-3261.

6.2.4 Pressure Vessel Internal Inspection

If deficiencies are identified during external inspections, such as cracks, evidence of corrosion, etc., perform an internal inspection in accordance with NBIC-23 Section RB-3232. Internal inspections are also performed when corrosion rates control the life of the pressure vessel.

Basis: UMC Section 1025.0/1025.4, and P 101-34 *Pressure, Vacuum and Cryogenic Systems*.

6.2.5 Inspection/Testing of Pressure Relieving Devices

6.2.5.1 Testing and Replacement Intervals

The following table indicates pressure relief device set point verification test and replacement intervals.

Table 4

Pressure Relief Device Maintenance Intervals

Fluid Service/Type	Test Frequency (Years)[1]	Reuse or Replace Device	Reused Device Treatment
Corrosive or Harsh Service: When harsh internal or external environment, corrosives, glutinous, acidic, or reactive fluids, rust likely, or otherwise damaging environments	2	Reuse or Replace	Clean and Test
Dewar vessel service (except for O2)	5	Reuse or Replace	Test
Inert gas or non-corrosive liquids (including dry air kerosene, non-acidic oils, etc.)	5	Reuse or Replace	Test
Natural Gas, LP, and Propane	5	Reuse or Replace	Test
Oxygen (dewar or gas)	3	Reuse or Replace	Test and reclean
Refrigerant (Henry, Superior, etc.)	5	Reuse or Replace	Test
Rupture Disk Reverse Buckling: If Damage Ratio is less than or equal to 1.0	N/A	Replace as required	N/A
Rupture Disk Reverse Buckling: If	2	Replace	Replace

damage ratio is greater than 1.0[2]			
Rupture Disk Flat/Forward Buckling in plugging service	2 yr inspection after installation	Establish inspection interval based on results of inspection.	Reuse or Replace based on results of inspection
Rupture Disk Flat/Forward Buckling in lethal service	N/A	Evaluate discharge for safety	N/A
Rupture Disk Flat/Forward Buckling and Bent/Breaking pins (non-plugging and non-lethal service)	N/A	Replace as required	N/A
Steam (ASME BPV Section I / power boilers)	1	Reuse or Replace	Test
Steam (ASME Sec IV/VIII)	2	Reuse or Replace	Test
Steam Pilot Relief Valve	2	Reuse or Replace	Complete disassembly and test
Water -- Domestic Water Heater	5	Replace	N/A
Water if treated and other liquids non-reactive-to-valve and not listed elsewhere in table	5	Reuse or Replace	Clean and Test
Water in ASME Section IV heating boilers	2	Reuse or Replace	Test

Notes:
[1]The Pressure System Owner must petition the CPSO for longer test and inspection intervals if historical data has been collected which supports that change. Conversely, if trend data indicates that inspection intervals should be reduced, the Pressure System Owner should make the associated change in the Computerized Maintenance Management System (CMMS).
[2]If installation direction cannot be verified or the damage ratio is 1.0, disk must be replaced every 2 years.

Basis for table is EMRef-58 (EMRef is a Standards Program system for maintaining references/bases)

Testing may be accomplished by the owner on the unit where the valve is installed or at a qualified test facility.

Note: For inspection of rupture discs, or other non-reclosing devices refer to NBIC-23, Section RB-3570d. Testing of other types of pressure relieving devices may be performed in place if the service fluid is non-hazardous.

1. Lifting the test or try lever when the pressure vessel is in service.

Note: Only boilers with an operating pressure of 15 psig should be considered safe to lever lift.

2. Testing of pressure relief device set points can be performed with the valve installed in the system or by bench test. The PSO must be present for in-place set point verifications, and flow tests. In-place testing must be performed using a PSO approved procedure. (See ASME PTC-25 for relief device testing requirements.)

3. Any relief device that has been modified, (e.g. spring replacement, orifice exchange, welding, etc.) except for set point adjustments, must be flow tested to verify capacity and operation. Flow tests must be documented and maintained in the pressure system documentation package. (See ASME Section VIII, Division 1, Part UG-131.)
4. Regardless if the relief device is ASME Code stamped (UV) or not, where in-place set-point testing of relief devices is the preferred method of testing, the system must be provided with a traceable calibrated gauge. Tolerance on set-point verifications must be +/- 2 psi for a set pressure less than 70 psi. For set points greater than 70 psi, the tolerance must be +/- 3% of the stamped set point as defined by ASME BPV Section VIII, Div 1, part UG-126(d).
    a. ASME (UV) stamped valves requiring disassembly to change the set point (i.e. spring replacement) must be performed by an organization accredited by the National Board, holding a "VR" stamp, to disassemble the valve and change the set point.
    b. ASME (UV) stamped valves that do not require disassembly to adjust the set-point, to the stamped set point indication, do not require an organization holding a VR stamp to make the adjustment.
    c. Adjustments of set point pressure on relief devices (regardless of UV stamp) must be performed by a LANL approved, and designated relief device testing facility.
5. All tested valves (regardless of UV stamp) must have, affixed by the testing organization, a "Test Only" tag as described by NBIC Part 3 (*Section 5.9.4*) with a minimum of the following information:
    a. Test report number (unique identification number)
    b. Name of testing organization, LANL test shop identification, or in-place flow procedure document number.
    c. MAWP
    d. Set pressure
    e. Date of test
    f. Due date of next test (as defined in this document)

6.2.5.2 Testing Fluids

Pressure relief devices (regardless of ASME Code stamp) that are removed from the system and sent to either a VR holder or CPSO-authorized testing organization must be tested using the following fluid media as defined by NBIC/NB-23, Part 2.

Fluid System:	**Valve test medium:**
High pressure boilers	Steam
High temperature hot-water boilers	Steam
Low pressure steam heating boilers	Steam

Programmatic and process steam service	Steam*
All other valves marked for steam service	Steam
Hot water heating boiler	Air or water
Hot water heater temperature and pressure relief valves	Air or water (replacement is preferred)
Air and gas service	Air or Nitrogen
Liquid service	Water

*air is suitable provided the manufacturers steam to air correction factor is used

*6.2.5.3 **Rupture Discs***

The inspector checks the markings on rupture discs to ensure that the stamped burst pressure and temperature are correct for the intended service conditions.

Rupture discs can only be tested to failure. A new disc needs to be installed after a test.

6.2.6 Corrosion and Remaining Life

1. Corrosion Analysis must be maintained in the pressure system documentation package for those systems containing fluids of corrosive characteristics.
2. Remaining life can typically be calculated as follows:

$$\text{Remaining life} = \frac{(t_{actual} - t_{reqd})}{\text{Corrosion Rate}}$$

$$\text{Corrosion Rate} = \frac{t_{initial} - t_{actual}}{\text{time}}$$

Where:
t_{actual}=The actual minimum thickness determined at the time of inspection
$t_{initial}$=Initial thickness (long-term corrosion rate) or thickness measured in a previous inspection (short-term corrosion rate)
t_{reqd}= the required minimum thickness
time= time between thickness measurements

Basis: API 570 “Piping Inspection Code”, Section 7 and NBIC Part-2, Para. 4.4.7.2

6.2.7 CMMS Database

*6.2.7.1 **Required Data***

Relief devices and non-excluded vessels must be entered and tracked using the CMMS maintenance tracking database, and must be maintained current and accurate. The following data is required:

1. The following data fields are required to be entered for all pressure protection items:
    a. Pressure system identification/inventory database number.
    b. Location
    c. Component I.D. number string (CLI number)
    d. Component Description
    e. Op-System (for programmatic, allowing PXXXXX code, where "X" is the system I.D. number including any leading zeros on the ID tag)
    f. Working Fluid
    g. Fluid Service (FS) code
    h. Manufacturer (and model number)
    i. Next inspection/test due date.
    j. Class: Management Level
    k. Inspection/Test frequency
2. Additional data for pressure vessels
    a. National Board number
    b. Maintenance Program Code ("P" for pressure vessels, "R" for relief devices) iii. Type of inspection or Model Work Order (UT, RT, etc)

6.2.8 DMAPS Database

1. Vessel inspection data must be entered into the DMAPS Database program. Contact QA-PM inspection team for assistance.
2. A copy of the vessel inspection report produced by DMAPS must be provided to the pressure vessel owner.
3. Vessel inspection reports must be maintained in the pressure system documentation package.

6.2.9 Repairs or Alterations (Welding)

1. Repairs and alterations that require welding to code stamped vessels ("U", "U2", etc) must be performed as instructed per the applicable ASME Boiler and Pressure Vessel Section, and must be performed by an institution holding an "R" stamp.
2. ASME PCC-2 must be used as a guide for repair of pressure equipment and piping.
3. Repairs to Piping, and piping components must be performed as defined in ASME B31.1 or ASME B31.3.
4. Repairs to relief devices displaying the "UV" stamp, must be performed by an institution holding a "VR" stamp.
5. Repairs and modifications to pressure vessels and piping must be verified through engineering calculations prior to performing the operation.
6. Completion of repairs and alterations must be verified by inspection and testing as defined by the applicable ASME BPV or B31 code, and NBIC/NB23, Part 3,

Section 4. Inspectors Forms (R-1, R-2, etc) must be maintained in the pressure systems documentation package.

7. Repairs and alterations made to ASME Section III stamped nuclear facility components (e.g., "NV", "NB") must be performed by an institution holding the "NR"

7.0 RECOMMENDED AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on the unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

Operation of air receivers includes the accumulation of condensation in the vessel. A weekly program is recommended that includes slowly opening manual drain valves to assure that the automatic drains are functioning properly. Inspection of the "torpedo" oil/water separators for saturation is also recommended.

Basis: Engineering Judgment: Experience at LANL has shown that automatic traps occasionally plug-up, and a weekly inspection will prevent saturation of the air system with water.

7.1.1 Major Emergency Repairs

If need be, obtain the services of an outside ASME certified service company for major emergency repairs, such as pressure vessel repairs, modification of supports, etc. There are several of these companies in Albuquerque, New Mexico and are licensed by the State of New Mexico, Construction Industries Division. Most of these companies provide 24-hour emergency service.

Basis: LANL pressure vessel maintenance experience.

7.2 Maintenance Recommendations

7.2.1 Vertical Mounting

Mount the valve in a vertical position so that discharge piping and code-required drains can be properly piped to prevent build-up of backpressure and accumulation of foreign material around the valve seat area.

7.2.2 Gaskets

When installing flange-connected valves use new gaskets and draw the mounting bolts down evenly.

7.2.3 Installation

1. Do not use the valve outlet or cap as a lever for installation. Use only flat-jawed wrenches on the flats provided.

2. Arrange discharge piping (if used) so that it cannot bear on the valve when either hot or cold, by using a drip pan elbow or flexible connection between the valve and the escape pipe.

7.2.4 Pressure Vessel Repair

Obtain the services of an outside ASME certified service company for pressure vessel repairs, modification of supports, etc. There are several of these companies in Albuquerque, N.M. and are licensed by the State of New Mexico, Construction Industries Division. Most of these companies provide 24-hour emergency service.

Basis: LANL pressure vessel maintenance experience.

7.3 Safety Valve Repair

7.3.1 Visual Inspection

Develop a regular program of visual inspection, looking for steam and condensate leaks, clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.

7.3.2 Painting

Do not paint, oil or otherwise cover any interior or working parts of any relief devices. Relief devices do not require any lubrication or protective coating to work properly.

8.0 GUIDANCE

8.1 Operations Guidance

None.

8.2 Maintenance Guidance

LANL preventative maintenance procedures (PMIs) related to pressure relief devices are available in the following documents: 40-25-039, *Boiler Relief Valve Testing*; 40-25-040, *Pressurized Tank Relief Valve Testing*; 40-25-041, *Pressurized Vessel Relief Valve Testing*.

9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained by FODs for pressure vessels and pressure relieving devices to include, as a minimum, the parameters listed in the Table 9-1 below:

Table 9-1: Maintenance History Documentation Parameters

Parameter	ML 1	ML 2	ML 3	ML 4
Manufacturer's Name Plate Data	**Required**	**Required**	**Required**	**Required**
Maintenance Activities				
Repair / Adjustments including qualifications of repair organization	**Required**	**Required**	**Required**	**Required**
PM Activities	**Required**	**Required**	**Required**	**Required**
Replacement (includes dates)	**Required**	**Required**	**Required**	**Required**
Equipment Problems				
Failure Dates	**Required**	**Required**	**Required**	**Required**
Failure Root Cause	**Required**	**Required**	**Required**	**Required**
Inspection Results				
Inspection Date(s)	**Required**	**Required**	**Required**	**Required**
SSC Condition	**Required**	**Required**	**Required**	**Required**
Vessel Pressure rating and temperature	**Required**	**Required**	**Required**	**Required**
ASME Code Stamp, National Board Number	**Required**	**Required**	**Required**	**Required**
Inspection permit provided and conditions noted	**Required**	**Required**	**Required**	**Required**
Date of Last Inspection	**Required**	**Required**	**Required**	**Required**
Wall Thickness Measurements (if performed)	**Required**	**Required**	**Required**	**Required**
Normal Contents of Vessel	**Required**	**Required**	**Required**	**Required**
Normal Operating conditions (temperature and Pressure)	**Required**	**Required**	**Required**	**Required**
'-' indicates documentation is not required				

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of P 950, Section 3.5.15 which states, "A maintenance history

and trending program is maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components."

10.0 REFERENCES

The following references, and associated revisions, were used in the development of this document.

10.1 American Petroleum Institute Standards documents:

Pressure Vessel Inspection: API 510, 572, 573

Pressure Relief Devices: API 520, 521, 576

Piping: API 570, 574

Fitness for Service: API 579

Risk-Based Inspection: API 580, 581

10.2 AP-341-502, I

10.3 AP-341-516, *Operability Determination and Functionality Assessment*

10.4 ASME CSD-1-1998, *Controls and Safety Devices for Automatically Fired Boilers*

10.5 ASME Section VI, *Recommended Rules for the Care and Operations of Heating Boilers*, 1998.

10.6 ASME Section VIII, *Pressure Vessels*, 1986

10.7 Electric Power Research Institute, *A Review of Equipment Aging Theory and Technology*, NP-1558, Palo Alto,CA, September 1980

10.8 EM Ref. 59

10.9 *Irradiation Effects on Polymers*, Chap. 3 "Radiation Resistance of Polymers and Composites" R. L. Clough and K.T. Gillen (1991)

10.10 *Irradiation Effects on Polymers*, Chap. 9 "Polymers in the Nuclear Power Industry" D.C.Phillips and S.C. Burnay (1991)

10.11 National Board Inspection Code, 2001

10.12 P 315, *Conduct of Operations Manual*

10.13 P 950, Conduct of Maintenance

10.14 PD 342 *Engineering Standards Manual*, Chapter 17

10.15 *Radiation Effects on Organic Materials*, Nucleonics, Vol. 18, No. 9. J.G. Carroll, R.O. Bolt (1960)

10.16 Uniform Mechanical Code, 1997

11.0 APPENDICES

None.