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**Record of Revisions**

<b>Rev.</b>	<b>Date</b>	<b>Description</b>	<b>POC</b>	<b>OIC</b>
0	3-10-09	Initial issue.	Charles DuPre, <i>ES-DE</i>	Kirk Christensen, <i>CENG-OFF</i>
1	7-29-09	Revised 1.0.E scope; 5.0 FS categories; 7.0(A) excluded systems; 8.0(B) requirements for relocated or removed systems; 9.I discrepancy actions; 10.T.16 fire sizing; 10.T.18, boiler requirements (from D30HVAC); 11.B future pre-testing of certain PRVs; 12.C required PMTs and PMs; 13.0.B.3 cylinder retest (corrected); FM01 and 06.	Charles DuPre, <i>ES-DE</i>	Gary Read, <i>CENG-OFF</i>
2	8-2-09	Clarified 9.0.B, C, and G and 9.0.I regarding handling of deficiencies.	Charles DuPre, <i>ES-DE</i>	Gary Read, <i>CENG-OFF</i>
3	5-12-10	General revision to incorporate approved clarifications, alternate methods, and lessons learned. LASO concurrence per "ESM 17 Draft Revision," email Vozella to Steinberg, 5/6/2010 (EMRef-62).	Charles DuPre, <i>ES-DE</i>	Larry Goen, <i>CENG-OFF</i>

PLEASE CONTACT THE ESM CHAPTER POC (CPSO)

for upkeep, interpretation, and variance issues

<b>Section I</b>	<b><u><a href="#">Pressure Safety POC &amp; Committee</a></u></b>
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The LANL Engineering Standards including this one are available to all at <http://engstandards.lanl.gov>

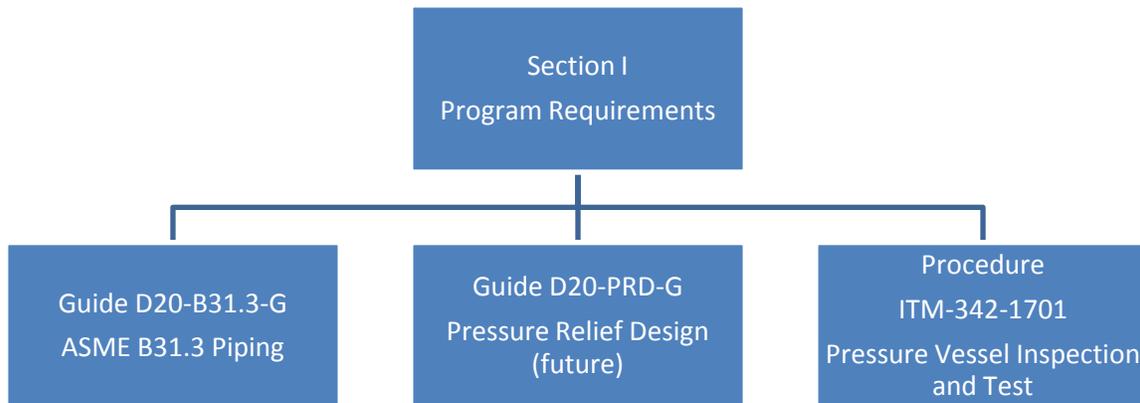
ES-Div Pressure Safety Webpage (internal); <http://int.lanl.gov/orgs/es/pp/index.shtml>

Additional resources for the implementation of this document are available to all LANL personnel at the following SharePoint site (Username: Z No., Password: WIN login):

<http://wespsrv1:19567/sites/ADE/COE/SWREF/Documents/Forms/AllItems.aspx>

**1.0 Introduction and Applicability**

- A. This Section I Program Requirements of Engineering Standards Manual Chapter 17 Pressure Safety contains the requirements for design and management of pressure systems to ensure that both new and existing systems are compliant with applicable ASME codes or equivalent as required by [10CFR851](#) Appendix A, Part 4 (reproduced as Appendix A of this document).



- B. This chapter establishes the design, review, testing, and pressure program management requirements for pressure systems in use at LANL. The operational safety requirements can be found in LANL Procedure [P101-34](#); however, such safety requirements must be taken into account when designing and working with pressure systems.
  - 1. Examples of such safety requirements not covered by this chapter are: personal protective equipment, skin injection, moving of gas cylinders, securing of gas cylinders, cryogen burns, chemical hazards, oxygen deficiency, operation and maintenance training requirements, etc.
- C. Pressure systems (facility and programmatic) that are subject to a source pressure greater than 15 psig (pounds per square inch gauge) are subject to the requirements of this program and the applicable ASME BPVC and B31 piping codes except as noted.
  - 1. Cryogenic systems that are not open to the atmosphere at all times are also subject to the requirements of this document due to the potential hazardous energy storage in the cryogenic fluid.
  - 2. Pressure systems with source pressures always less than 15 psig are not subject to the inventory and certification process as defined in this document. Examples of excluded systems: atmospheric tanks<sup>1</sup>, and other applications listed under Section 7.0, Excluded Pressure Vessels, Relief Devices, and Systems.

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<sup>1</sup> Atmospheric tanks must be protected from over/under-pressure by vacuum breaks and/or vents.

- D. Projects Underway: Projects in design or fabrication stages must also follow this chapter and must be in full compliance prior to fluid introduction including system pressure testing (not component or pipe section testing).<sup>2</sup>
1. In addition, existing systems are subject to the certification and preventive maintenance requirements herein, as well as being expected to maintain (but generally not reproduce) required documentation.<sup>3</sup>
- E. Throughout this document there are references to specific ASME code paragraphs or sections. For most cases across the Laboratory, the appropriate codes are B31.3<sup>4</sup> and Section VIII of the Boiler and Pressure Vessel Code. However, the most applicable code must be used for design, fabrication, inspection, and testing; take requirements in this document referring to or taken from B31.3 to mean the corresponding provisions in the applicable B31 code.
1. For example, use B31.1 for site steam distribution, B31.5 for refrigeration piping, and B31.9 for building services where the Plumbing Code does not apply.
- F. Documentation, including forms, generated by this program must be considered records, and must be managed per LANL P 1020, P 1020-1, and P 1020-2 located [here](#).

## 2.0 Section Overview

- A. This section addresses the process by which pressure systems and their components are to be certified for use. The key areas of this document are: ASME code requirements, configuration control, inspection and testing, design oversight, documentation requirements, and pressure systems accountability and traceability.<sup>5</sup>
- B. Contact the Chief Pressure Safety Officer ([CPSO](#)) for questions regarding the subject matter of this document, applicability, or interpretations. When greater levels of assistance are required, an Engineering Services Request must be submitted (link on ES Division Pressure Protection Program [website](#)).
- C. Request for variance from compliance with this Chapter, or alternate methods and clarifications, must be submitted to the CPSO, for review and approval processing.
- D. Alternate Method/Variance Approval
1. Approval of an alternate method or variance can occur under the following circumstances:
    - a. To permit continued operation prior to correction of deficiencies
    - b. To permit a long-term operation with a condition that deviates from this document.

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<sup>2</sup> Although ESM Ch 1 Section Z10 normally grandfathers projects underway for new requirements, the need to comply with 10 CFR 851 as implemented by this chapter supersedes that allowance; furthermore, compliance prior to startup ensures safety and is more cost-effective than program backfit after fluid introduction.

<sup>3</sup> Unlike most ESM chapters, this is a complete program and not only for new installations.

<sup>4</sup> For the applicability of ASME B31.3 see B31.3 Para 300.1.1 regarding the content and coverage.

<sup>5</sup> Programs in similar industries and national standards were used in the generation of this program. Industries include: White Sands Test Facility (NASA) and Savannah River Site (DOE). Primary national standards and guidelines used: NBIC, Code of Federal Regulations, API, and the ASME Boiler and Pressure Vessel and B31 series codes.

- c. Requests for variance could include systems where installation of pressure relief devices is impossible (such variances must be reviewed for applicability against ASME Code Case 2211 and ASME Section VIII, Division 1, Part UG-140).
2. Approval is requested per ESM Chapter 1 Section Z10. Owner must submit a Conduct of Engineering Request for Variance or Alternate Method, LANL Form [2137](#), ideally using the ES Division [Engineering Service Request](#) System available from ES-Div homepage.
3. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.<sup>6</sup>
4. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10 CFR 851.
5. Variance approvals must be documented and maintained with the pressure system documentation package
  - a. The master list of approved variances, alternate methods and clarifications is maintained on the Chapter 17 and Program [websites](#).
  - b. Variances cannot conflict with a safety basis or TSR.

### 3.0 Qualification Requirements

#### A. Pressure System Designers<sup>7</sup>

The Designer is the person in charge of the engineering design of a piping system and shall be experienced in the use of the applicable ASME Code. The qualifications and experience required of the Designer will depend on the complexity and criticality of the system and the nature of the individual's experience. The Designer shall meet at least one of the following criteria:

- (a) Completion of an Accreditation Board for Engineering and Technology (ABET) accredited or equivalent engineering degree, requiring the equivalent of at least 4 years of study, plus a minimum of 5 years experience in the design of related pressure piping.
- (b) Professional Engineering registration, recognized by the local jurisdiction, and experience in the design of related pressure piping.
- (c) Completion of an accredited engineering technician or associates degree, requiring the equivalent of at least 2 years of study, plus a minimum of 10 years experience in the design of related pressure piping.
- (d) Fifteen years experience in the design of related pressure piping.

Experience in the design of related pressure piping is satisfied by piping design experience that includes design calculations for pressure, sustained and occasional loads, and piping flexibility.

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<sup>6</sup> On 8/14/09, LASO and LANL agreed that LASO would be copied on all LANL approved variances associated with FS1 systems. Further, LASO will be copied on all LANL approved variances associated with Safety Class or Safety Significant systems, regardless of the fluid system category (EMRef61: "Pressure Safety at WETF...Nuclear Facilities," Email, J. Vozella to K. Carr et al, 8/14/2009). Additionally, LASO will be notified of any deficiencies discovered in Safety Class or Safety Significant systems.

<sup>7</sup> ASME B31.3 Article 301.1 Qualifications of the Designer

**B. Owner's Inspectors<sup>8</sup>**

The Owner's Inspector shall have not less than 10 years experience in the design, manufacture, erection, fabrication, or inspection of pressure piping. Each year of satisfactorily completed work toward an engineering degree recognized by the ABET shall be considered equivalent to 1 year of experience, up to 5 years total.

**C. Pressure Safety Officers**

Pressure Safety Officers shall be trained and qualified in accordance with requirements stipulated in the Engineering Training and Qualification Manual, [PD343](#) (*Interim Training Plan 11297; Full Qual TP 11146*).

**4.0 Pressure Safety Committee**

- A. The Pressure Safety Committee (also know as Chapter 17 Technical Committee) is chaired by the CPSO (POC of ESM Chapter 17). Members are appointed by the CPSO and typically include the PSOs and others from around the laboratory whom the CPSO may call upon to review and provide input as requested on variances, alternate methods, clarifications, and interpretations with respect to Chapter 17.
- B. SMEs are not permanent members of the pressure safety committee but have experience in areas relevant to the topic of discussion. For example, a welding SME may be engaged on welding or brazing questions but their involvement is not required when evaluating a pressure system that will be assembled with compression fittings.

**5.0 Definitions and Acronyms**

**Alteration** – The change of a pressure-boundary component that changes the original design structure. Does not include the removal and replacement of components, but modification of the component itself (e.g., welding an additional port to a U-stamped vessel).

**ASME B31** - American Society of Mechanical Engineers Piping codes.

**ASME BPVC** – American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

**Authorized Inspector (AI)** – An inspector regularly employed by an ASME accredited Authorized Inspection Agency in accordance with the requirements in the latest edition of ASME QAI-1.

**Category D Fluid** – A fluid service which is nonflammable, nontoxic, not damaging to human tissues, does not exceed 150 psig, and the design temperature is between –20 °F to 366 °F [ASME B31.3].

**Category M Fluid** – A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken [from ASME B31.3 300.2 definition for fluid service].

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<sup>8</sup> ASME B31.3 Article 340.4 Qualifications of the Owner's Inspector

**Certification** – All requirements of this document have been met and CPSO or delegate has approved pressure system for use. Is not to be understood as an ASME or NBIC certification, it is only a permit to operate the pressure system, granted by the CPSO.

**Check Valve** – (see system interaction below) – A spring loaded poppet valve that has one flow direction to keep system contents from back flowing.

**CMMS** – Computerized Maintenance Management System (See PassPort).

**Code Equivalent** – A Pressure vessel or other component that, through documentation, proves that the design meets all of the design, fabrication, test, and inspection requirements established by the applicable code, but does not have a code stamp and does not require a code certified Inspector.

**Code Non-compliance** – A violation of a national consensus code (e.g., ASME), or the lack of documentation demonstrating code-equivalent fabrication.

**Components** – The set of items within a piping system which are joined together and make up a functioning process. Piping components are a sub-set of all components in a piping system. See definition of Piping Components below for those components which are within the scope of the B31 pressure piping codes. Other components which make up a process (e.g., pumps, heat exchangers, etc.) are designed and fabricated in accordance with other industry codes and standards. Acceptable component acronyms for design documents, labels, and CMMS are addressed in ESM Chapter 1 [Section 200](#).

**Corrosive Service** – A fluid service in which the internal fluid, or external environment, is expected to produce a progressive deterioration in the pressure boundary material.

**CPSO** – Chief Pressure Safety Officer –Point of Contact (POC) for this chapter and thus the LANL Pressure Safety Program. Final approver in system certification. Is a subject matter expert in pressure systems design, will assist system owners with applicable codes for pressure system design. Reviews and approves variations and alternate methods. May delegate certain functions to Pressure Safety Officers.

**Cryogenic Fluids** – Fluids with a normal boiling point below -200 °F. Other fluids, (i.e. CO<sub>2</sub>, refrigerants, etc.) that are not necessarily considered cryogenic, must be taken into consideration as having similar pressure hazards as that of cryogenics.

**Damage Ratio:** A damaged rupture disk will burst at some pressure other than that predicted. This disparity can be reported by a value called the "damage ratio." The damage ratio is equal to the actual burst pressure of a damaged disk divided by the stamped burst pressure. A damage ratio of 1 or less provides assurance that the disk, even damaged, will burst at or below the stamped burst pressure, while a value higher than one would indicate the actual burst pressure could exceed the stamped burst pressure. As an example, a damaged disk with a 100 psig stamped burst pressure and a damage ratio of 1.5 could have an actual burst pressure of 150 psig. This information can be provided by the burst disk manufacturer.

**DCF** – Design Change Form. See [AP-341-517](#). Used to make simple permanent modifications to configuration controlled structures, systems, and components (SSCs) in hazard category 2 and 3 nuclear facilities, and high and moderate hazard non-nuclear facilities, when the use of AP-341-518, Modification Traveler is not justified. Used when designs do not require significant or long term commitments of engineering and craft, the design is being performed by the System Engineer with

minimum help from other engineering disciplines, and the modification primarily involves a single engineering discipline.

**DCP** – Design Change Package. See [AP-341-505](#).

**Deputy Chief Pressure Safety Officer** – Delegated by the CPSO. Alternate POC for this Chapter. Has signature authority for final approval of pressure system documentation packages.

**Design Pressure** – Design Pressure is that pressure determined by the designer, for which the system or component must operate at worst case conditions/temperatures during normal operation (see ASME Section VIII Div 1, Part UG-21 and B31.3 Para. 301.2).

**Dewar** – A vacuum flask or vacuum-insulated shipping container used for storage of cryogenic fluids. Named for the inventor, Sir James Dewar.

**ECN** – Engineering Change Notice. See [AP-341-506](#).

**Engineering Calculation** – To be performed as defined in AP-341-605 on all pressure relief valves, and as required by the applicable ASME code.

**Engineering Services Division** – Performs or facilitates detailed calculations and other design functions to aid PSO and system owners.

**ESM** – LANL Engineering Standards Manual (PD342)

**Examiner** – An individual with the training and experience commensurate with the needs of the specified examinations. It is the person who performs the quality control examinations and is performed by the manufacturer, fabricator, or erector. See ASME B31.3 Chapter VI, paragraph 341.

**Excluded Systems** – Pressure systems that are not considered to be within the scope of the pressure safety program. Examples include, but are not limited to: vehicle pneumatic systems, propane-powered vehicles, and garden irrigation systems.

**Facility Pressure System** – Any liquid or gas pressure system that is maintained by the facility operations director, or where the cost of maintenance or repair is paid for by the facility, not the program it supports (e.g., building heating boilers, instrument air system, etc). Normally found in utility rooms that provide building services.

**Fault Condition** – Any failure caused by component failure, human error, chemical reaction, or environmental conditions that may cause an increase in pressure above the MAWP of the component or system.

**Flexible Element** – A flexible element of a pressure or vacuum system including hoses, used in place of a pipe or rigid metal tubing. Also referred to as flexible tubing or flex-hoses.

**Fluid** – A chemical in gaseous or liquid (or sometimes solid) state which can be pressurized or be the pressure source in a pressure system.

**FS Categories** – LANL-specific fluid service category which allows a graded approach for deficiency resolution in existing systems for both pressure vessels and piping. LANL fluid services are based on the fluid categories defined by ASME B31.3 Paragraph 300.2, thus:<sup>9</sup>

- **FS1**- Fluid systems for which fluid category has been determined to be either Category M or High Pressure as defined in ASME B31.3, where these categories are defined as follows:
  - Category M: A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken.
  - High Pressure Fluid Service: Pressure in excess of that allowed by the ASME [B16.5](#) Class 2500 rating for the specified design temperature and material group (see full definition below).
- **FS2** - Fluid systems not FS1 or FS3. Here, the fluid category is or would equate to Normal as defined in ASME B31.3 (i.e., not Cat D, M, or High Pressure).<sup>10</sup>
- **FS3** - Fluid systems for which the fluid category is or would equate to Category D as defined in ASME B31.3, thus: 1) the fluid handled is nonflammable, nontoxic, and not damaging to human tissues; 2) the design gage pressure does not exceed 150 psig; and 3) the design temperature is from -20°F through 366°F. Steam systems cannot be FS3.<sup>11</sup>

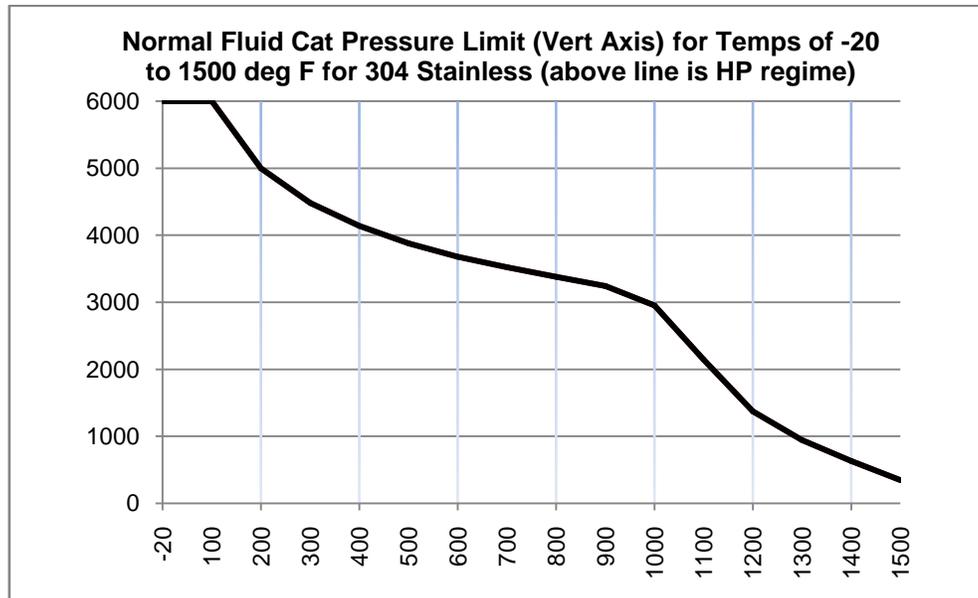
**High Pressure Fluid Service** – Pressure in excess of that allowed by the ASME B16.5 Class 2500 flange rating for the specified design temperature and material group. This category is dependent upon material type at temperature. The example chart below illustrates the function of temperature versus pressure for Type 304 stainless; notice how “high pressure” could be as low as 345 psi at a given temperature. The chart below is only one example using B16.5 table data. See also Chapter IX of ASME B31.3.

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<sup>9</sup> Similarly, a graded approach can be found in API 570 “Piping Inspection Code.” FS Categories are LANL fluid categories, not ASME Code categories. FS categories are not intended to provide design guidance (e.g., an FS1 pressure system does not necessarily need to be designed and built for ASME Category M fluid service, unless of course, the FS1 system contains fluids that meet the ASME definition of Category M). Where consensus cannot be accomplished, the CPSO must make the final determination of fluid service category.

<sup>10</sup> “Equate to” is added here and for FS3 so that fluids in piping subject to B31 codes other than B31.3 may use the B31.3 category definitions for the purposes of LANL’s graded approach which based on B31.3 definitions.

<sup>11</sup> Because steam is damaging to human tissue, LANL chooses to treat as FS2 for deficiency resolution reasons .



**Hydraulic Systems** – Those systems which use an incompressible fluid as the pressure media to perform work. These systems normally include pumps, piping, pressure safety valves, and accumulators.

**Hydrostatic Test** – A test performed on a pressure vessel or system in which the vessel or system is filled with a liquid (usually water) and pressurized to a designated level.

**In Service Leak Test** – Joint examination at normal operating conditions to verify absence of leakage.

**Inspector** – Verifies all required examinations and testing have been completed and inspects to the extent necessary to be satisfied that the design of the system conforms to all applicable examination requirements of the Code and of the engineering design (see ASME B31.3, Chapter VI, 340).

**Leak Test** – A general term used to describe a pressure test which proves the integrity of a pressure boundary. More specific terms are: hydrostatic leak test, pneumatic leak test, initial service leak test, and sensitive leak test. These tests are described in ASME B31.3, Section 345.

**Lethal Substance** – Poisonous gases or liquids of such a nature that a very small amount of the gas or of the vapor of the liquid mixed or unmixed with air is dangerous to life when inhaled. This class includes substances of this nature, which are stored under pressure or may generate a pressure if stored in a closed vessel.

**Major System Modification** – The addition of or modification to a pressure vessel, removal of a pressure relief device, replacement of a pressure relief device that is not an exact replacement or engineered equivalent, modification of the pressure relief path that materially changes its capacity, or any other change which calls into question the capacity or set point of the relief device(s). Major System Modifications require recertification of the system.

**Manufacturer's Service Rating** – The service rating (MAWP and design temperature) of a component, pipe, or tube available on the open market which has been designed and tested to a recognized guideline or military standard.

**Maximum Allowable Working Pressure (MAWP)** – Typically stamped on individual components (or sub-components) of a pressure system. Is the maximum permissible pressure (internal or external) of a pressure component (or system) when operated in its normal operating position at the designated coincident temperature specified for that pressure. It is the least of the values found for maximum allowable working pressure for any of the essential pressurized components of a pressure system as defined in ASME Section VIII Div 1, Part UG-98 (see also Part UG-23). Value is typically less than the component burst pressure by a factor of safety defined by the ASME Code.

**Maximum Operating Pressure (MOP)** – The maximum intended operating pressure, typically less than the MAWP to prevent premature system leakage through pressure-relieving devices.

**Minor Non-compliance** – A LANL self-imposed requirement that is not a violation of a DOE Policy Directive or a national consensus code; e.g., missing/loose pipe brackets or unlabeled components.

**Mobile Pressure Containers** – Pressure vessels designed for travel on streets and highways; e.g., tube trailers, cryogen tankers, and other vessels mounted on trailers, trucks, etc. [ASME B&PV Code Section XII].

**Modification** – Any pressure system component change, addition, or deletion other than replacement of components with similar performance characteristics such as flow capacity and strength. This definition does not include alteration of pressure-boundary components (e.g., welding additional ports to pressure-bearing component – see “Alteration”).

**Non-Conformance Report (NCR)** – Process defined in LANL Procedure [P 330-6](#). Initiated by system owners, PSOs, or others when deficiencies require tracking and/or disposition. *At time of writing, this process was, at a minimum, applicable for code deficiencies or indeterminate conditions associated with an ML-1 or ML2 system or component.*

**Non-Destructive Examination (NDE)** – Examinations including visual examination, radiographic examination, ultrasonic examination, and dye-penetrant testing used to qualify the condition of a pressure vessel or component.

**Non-hazardous Fluids** – Any fluid or mixture that is nonflammable, nontoxic, and is not corrosive. Cryogenic fluids are considered hazardous.

**Normal Fluid Service** – A fluid service pertaining to most piping covered by the B31.3 Code but not subject to the B31.3 rules for Category M, Category D, or High Pressure fluid services.[B31.3, 300.2]

**Operating Pressure** – A pressure less than the MAWP at which the system is normally operated.

**Operating Temperature** – A temperature between the lower and upper design temperatures of the pressure system or component.

**Out-of-Service System** – A system that is formally designated inactive or not in use.

**PassPort** – LANL’s Computerized Maintenance and Management System (CMMS) software package that includes the Master Equipment List. Required by this pressure safety program for tracking relief valve testing and vessel inspections. Becoming Ventyx’s Asset Suite.

**Pilot-Operated Pressure Relief Valve** – A pressure relief valve in which the major relieving device is combined with and is controlled by a self-actuated auxiliary pressure relief valve (commonly used in hydraulic systems and some steam systems).

**Piping Components** – Mechanical elements suitable for joining or assembly into pressure-tight fluid-containing piping systems. Components include pipe, tubing, fittings, flanges, gaskets, bolting, valves, and devices such as expansion joints, flexible joints, pressure hoses, traps, strainers, inline portions of instruments, and separators [ASME B31.3, 300.2].

**Pneumatic Test** – A test performed on a pressure system or component in which a gas is introduced and pressurized to a designated level in a manner prescribed in the applicable code.

**Poly Tubing** – Term used for many types of flexible polymer tubing. Examples include Poly-Flo® and Tygon®.

**Portable Pressure Vessels** – Pressure vessels easily transported from one location to another but without mobile gear attached. Examples include portable dewars, Department of Transportation (DOT) compressed gas cylinders, and sample bottles (e.g. Hoke bottle, Swagelok sample cylinders).

**Pressure Pipe** – A relatively heavy-walled tubular fluid container/transporter that is normally attached or connected to fittings or components with threads or welds.

**Pressure Qualification Test** – A pressure test performed above the MAWP (design pressure) using a non-hazardous fluid to ensure the integrity of the pressure system, or component. For example, see ASME B31.3, Chapter VI. Typically for HVAC/Refrigeration systems this pressure is 130% (pneumatic) of the design pressure (ASME B31.5, Para. 538.4.2), and either 110% (pneumatic) or 150% (hydrostatic) of the design pressure for B31.3 systems. See also (as an example) ASME Section VIII Div 1 Part UG-99, UG-100, and UG-101 for further information.

**Pressure Relief Valve (PRV)** – Most common and preferred term for pressure protection valves at LANL used for a pressure relief valve which is actuated by inlet static pressure that opens in proportion to the increase in pressure over the opening pressure (typically liquid use).

**Pressure Safety Valve (PSV)** – Also known as a Pressure Relief Valve (PRV). A pressure relief device that is designed to re-close and prevent the further flow of fluid after normal conditions have been restored (typically gas or vapor service).

**Pressure Tubing** – Different from “Pressure Pipe.” Is a relatively thin-walled tubular fluid container/transporter that is normally suitable for bending and is attached or connected by flared fittings, compression type fittings, or welding.

**Pressure Vessel** – Containers for the containment of pressurized fluids, either internal or external. Excluded are pipe runs; however, a vessel may be fabricated from a section of pipe if the construction conforms to ASME code requirements. For this program, storage vessels such as 55-gallon drums are not considered pressure vessels and must not be pressurized by an external source.

**Programmatic Pressure System** – Any gas or liquid pressure system which is used for testing, manufacturing, research purposes, or used in support of testing, manufacturing, research processes. Maintenance or repair of these systems is paid for and/performed by the program, not the facility. Vessels and components that cannot be code stamped must be provided with documentation proving design is equal to or greater than the ASME code guidance in terms of testing, inspection, and over-pressure protection. Design and maintenance of these systems must comply with the most applicable ASME code (exception: see “Test Article”).

**Proof Test** – A pressure test performed to establish the maximum allowable working pressure of a vessel, system, or component thereof when the strength cannot be computed with a satisfactory assurance of accuracy. This test will be performed in a manner equivalent to one of the methods

specified in paragraph UG-101 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

**PSO** – Pressure Safety Officer. Is familiar with ASME code guidance, and performs system certification reviews (per this document) of pressure systems. Not required to perform design calculations, but aids system owners in compliance with this procedure and the use of the ASME code. A PSO can request an alternate or designee to help perform the functions defined in this document upon approval of the CPSO.

**Relief Valve** – PRV designed for liquid or liquid mixed with steam or gas.

**Reversal Ratio:** Is equal to the actual burst pressure of a rupture disk installed in reverse divided by stamped burst pressure. If the value is one or less, the disk will relieve at or below its stamped burst pressure even when installed in reverse. If the value is greater than one, the actual burst pressure will be greater than the stamped burst pressure. This information can be provided by the rupture disk manufacturer.

**Rupture Disk Device** – Also known as burst disk. A non-closing pressure relief device actuated by inlet pressure and designed to remain open after operation. The device performs its function by bursting a pressure-containing disk.

**Safety Relief Valve** – A pressure relief valve characterized by rapid opening or pop action or by opening in proportion to the increase in pressure over the opening pressure. Used for compressible or incompressible fluids.

**Safety Valve** – A pressure relief valve actuated by inlet pressure and characterized by rapid opening or pop action. Normally used to relieve compressible fluids.

**Set Pressure** – Set pressure is the value of increasing inlet static pressure at which a pressure relief device displays one of the operational characteristics as defined by opening pressure, popping pressure, start-to-leak pressure, burst pressure or breaking pressure.<sup>12</sup> Measured at the pressure relief valve inlet, at which there is a measurable lift, or at which discharge of a fluid becomes continuous. The terms open pressure, relief pressure, cracking pressure, and set points are equivalent when testing valves.

**Source Pressure** – The pressure supply source that provides pressure to a system. Examples include: gas cylinder, pump, heated vessel (boiler), cryogen dewar, trapped cryogen expansion, chemical reaction, etc. Is not regulated pressure.

**Stop Valve** – A valve that is installed between the piping or component being protected and its protective device (PRV) or between the protective device and the point of discharge. Although allowed by the ASME code, this design scenario is discouraged. Designs using stop valves in any manner that is not allowed by the ASME code must be approved by the CPSO.<sup>13</sup>

**Sub-Component** – Term used to describe an element which together with other elements comprise a component. For example: A boiler can be a component of a steam system, but the boiler itself is made up of sub-components (shell, tubes, PRV, etc.).

<sup>12</sup> ASME Section VIII, Division 1, 2007 edition, Footnote 61.

<sup>13</sup> See ASME B31.3 paragraph 322.6.1

**System** – Combination of multiple components (and possibly subcomponents) which together make a pressure system. Example 1: A steam system can be comprised of two main components: The boiler and the steam piping which runs throughout a building. Example 2: A gas chromatograph system may consist of a combination of components (or sub-components) such as: gas cylinder, manual valves, tubing, pressure transducers, flexible hoses, vacuum pump, and the GC.

**System Interaction** – Interactions among pressure systems that may cause a system to be over pressurized, or cause unwanted mixture of separate fluids, which necessitates the evaluation of all system interfaces (e.g., determination of check valve installation and placement). In extreme cases could warrant the use of dual check valves placed in series.

**System Owner** – The individual responsible for the overall operation, maintenance, design (code compliance), documentation, and/or construction of a pressure system.

**Tank** – A container whose contents are maintained at atmospheric pressure or below 15 psig at all times, and cannot be pressurized above 15 psig, even through fault conditions.

**Test Article** – An excluded pressure system/component. A component or system of components provided by a vendor, or is part of a research and design deliverable. Is temporarily installed in LANL facilities exclusively for the purpose of being tested for data purposes, or destructive purposes. Included in this definition are those test articles that are being designed by LANL personnel, which are considered product, and must undergo numerous design changes, modifications, and alterations.

Examples of excluded test article systems include flight hardware such as: WR pressure components and systems (e.g., vehicle-specific flight-weight tritium reservoirs and associated flight-weight plumbing/components), or space vehicle pressure components and systems (e.g., vehicle flight-weight propulsion or hydraulic systems/components). However, pressure systems that support the design, testing and/or evaluation of such hardware are not excluded.

**Vacuum System** – An assembly of components which may include vessels, piping, valves, relief devices, flex hoses, gages, etc., operated with the internal pressure reduced to a level less than that of the surrounding atmosphere. Some vacuum systems can be subjected to a positive pressure because of vacuum break and purging capabilities.

**Vacuum Vessel** – A vessel operated with the internal pressure reduced to a level less than that of the surrounding atmosphere.

**Vendor-Owned Equipment** - Pressure vessels and/or equipment owned by a vendor to transport, store fluids or gases, or to perform a support function on LANL property.

**Vessel** – For the purpose of this program, any pressure chamber, regardless of formed heads (e.g., dished, concave, convex, etc.) or cylindrical shape, which has been installed into a pressure system that can, through normal operation or fault conditions, be pressurized above 15 psig.

**Volumetric Weld Examination** – Examination of a full penetration weld by x-ray or ultrasonic testing.

## 6.0 General Program Statements

### A. Basic Program Requirements

1. Programmatic pressure systems, regardless of presence of vessels, where the source pressure is greater than 15 psig (including cryogenic, vapor pressure, chemical reaction and/or pump pressurized systems) must be designed to meet the requirements of the applicable ASME BPV and ASME B31 codes or CPSO-approved equivalent. These systems are subject to the certification requirements of this section.
2. Facility pressure systems (power boilers, heating boilers, shop supply air, etc) where the source pressure or pressure generated is greater than 15 psig are also subject to the certification requirements contained in this document (ASME Section IV boilers are not exempt).
3. Mobile and portable pressure systems that are 4 psig or greater (as defined by ASME Section XII) are also included in this program. These can include tube trailers, vehicle-mounted vessels, and skid-mounted vessels.
4. Pressure systems must have documentation proving compliance with the ASME code, or indicating excluded status, where the definition of excluded is defined in this document.
5. New pressure systems in preliminary design as of March 10, 2009 (date of issuance of Revision 0 of this Chapter) must be certified according to this document prior to use.
6. A phased approach will be implemented with regard to certification of existing pressure systems. The following timeline will be followed:
  - a. FY10: Completion of walkdown and tagging of high-risk systems (FS1 and FS2), including the following activities for those systems: preparation of relief device calculations for legacy devices, entry of pressure vessel and relief device data in the Master Equipment List, identification of pressure system deficiencies, and tracking of deficiencies in accordance with [PD322](#), Issues and Corrective Action Management.
  - b. FY11: Development of component model work orders and PM activation in CMMS for high-risk systems; certification of high-risk systems.
  - c. FY11: Completion of walkdown and tagging of low-risk systems (FS3), including the following activities for those systems: preparation of relief device calculations for legacy devices, entry of pressure vessel and relief device data in the Master Equipment List, identification of pressure system deficiencies, and tracking of deficiencies in accordance with [PD322](#).
  - d. FY12: Development of component model work orders and PM activation in CMMS for low-risk systems; certification of low-risk systems.
7. Pressure system owners must notify the PSO of existence of existing, new, or modified pressure systems.

8. The terms “inspection” and “certification” in reference to PSO, or other “walk-down” activities, in this section, does not constitute Authorized Inspector inspection process except where specifically noted.
9. Where this document refers to the term “Pressure system certification tracking database,” this reference is not the CMMS/MEL/PassPort Database system. Rather, it is a standalone (e.g., Lotus Domino) database used by CPSO/PSOs for maintaining an inventory of all pressure systems, configuration of pressure systems and tracking of pressure systems certification only, not for tracking of vessel, and relief valve inspection due dates.
10. Modifications to pressure vessels and pressure systems must follow DCP, ECN, or DCF formality as defined in AP-341-505, AP 341-506, or AP-341-517, whichever is applicable to the facility and program type. These Administrative Procedures are on the Conduct of Engineering AP [webpage](#).
11. Temporary facility modifications must comply with AP-341-504, where applicable to the facility. Programmatic systems must prove compliance by documenting the temporary modification and updating the IWD to ensure any new hazards have been controlled. Documents describing the design change and hazard mitigations must be reviewed by all those who originally signed the IWD, or their designee, to approve the temporary design change. Signed copies of design review, including any sketches and calculations, must be maintained with the controlled copy of the IWD.
12. Design document reviews must be performed as defined by [CoE](#) AP-341-620 or 622.
13. Classified systems are not excluded from this program. Classified data must be handled appropriately.
14. *For new pressure systems, the specifications and documentation submittals should be specified in the ECN, DCF or DCF work scope to ensure that the documentation necessary to certify the system is available upon completion of the work. These submittals may include ASME manufacturer data reports, vessel hydrotests and weld inspection reports, calculations for non-code vessels & custom components, piping & component cut sheets, B31.3 flexibility and thrust analyses, relief device capacity calculations and P&IDs.*

#### **B. Program Assessments**

The CPSO will perform an annual assessment to evaluate institutional compliance with requirements of the Pressure Safety Program as defined in this chapter. \_

## 7.0 Excluded Pressure Vessels, Relief Devices, and Systems

### A. Excluded Pressure Systems

CAUTION: Pressure systems, regardless of whether excluded or in this program, must be designed with appropriately sized pressure relief/vent systems. *For example, water holding tanks filled by pumps are considered excluded from this program; however, if the original pump on the water tank is replaced, a design review should be performed to ensure the pumping capacity of the new pump will not “out-flow” the capacity of the existing vent system.*

1. Pressure systems and/or components of pressure systems that cannot under any circumstance be designed in accordance with the ASME Boiler and Pressure Vessel Code or the B31 Piping codes or equivalent. These items shall be shielded behind blast containment designed to withstand the explosive forces and release of shrapnel in the event of over pressurization. Only after sufficiently designed shielding has been installed to protect the work force may the pressure system or components be considered excluded from the pressure safety program and the requirements of this document. They are not considered excluded without the protective shielding.
  - a. NOTE: Prior to determining that a pressure system cannot be designed in accordance with the codes, the owner and designer shall consider equivalency provisions in 10CFR851, Appendix A, Part 4, Section (c) (see Appendix A of this document) which provides an alternate methodology to be invoked in cases when codes are not applicable.
2. Temporary non-LANL-owned construction or maintenance related systems provided the hazards to personnel are low and the operating subcontractor is contractually obligated to meet, and demonstrates compliance with, all applicable Federal, State and local safety regulations.
3. Facility water and sewer systems such as drinking fountains, faucets, garden hoses, lawn sprinkler systems, et cetera, not governed by ASME BPV or B31 Codes.<sup>14</sup>
4. Packaged refrigeration (to include HVAC and refrigerators) units bought commercially, off-the-shelf, without modification, and not subject to B31.5.
5. Vent or drain systems that are open to the atmosphere at all times, including storage tanks (open to the atmosphere at all times) that only are subjected to hydrostatic pressure and that comply with the applicable American Petroleum Institute (API) or Underwriters Laboratories Incorporated (UL) standards.
6. Facility water wells, water tanks, and water distribution piping not subject to B31 codes.
7. Welding, brazing, or soldering equipment covered by other standards.

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<sup>14</sup> These are governed by the LANL ANSI/IAPMO-based Uniform Plumbing Code or other non-ASME document.

8. Commercially-available, off-the-shelf (COTS) equipment such as gas chromatographs and mass spectrometers. However, when connected to a pressure source, the pressure source hardware is not excluded and must be designed per ASME B31.3.
  - a) Program does include modified or custom fabricated/assembled systems.
9. Commercially-available alternative fuel vehicles, such as propane-powered vehicles (49 CFR)
10. Pre-packaged, unmodified, and off-the-shelf hydraulic power units (piping systems connected to such hydraulic units are not exempt if not designed and installed by the hydraulic unit manufacturer).
11. Fire suppression systems covered by NFPA Codes and Standards [e.g., NFPA 13 (sprinklers) and NFPA 14 (standpipes)]
12. Fire extinguishers covered by 29 CFR 1910 and NFPA 10.
13. Gloveboxes alone are excluded; however, purge and other pressure systems that interface with gloveboxes must have pressure relief that meets the requirements of ASME Section VIII, Division 1 Part UG-125 to keep the glovebox from being overpressurized.<sup>15</sup>
14. Test Articles (as defined in Section 5.0 - Definitions) and Test Article Systems must be shielded to prevent possibility of personnel injury; however, pressure systems that support the design, testing and/or evaluation of such hardware are not excluded. All research and development systems that must undergo continuous design changes must be reviewed by the CPSO.
15. Vacuum systems not pressurized internally or externally by a pressure source that is greater than 15 psig (source pressure can either be internal chemical reaction, or external pressure source) which is either temporarily or permanently connected.<sup>16</sup>

#### **B. Excluded Pressure Vessels**

1. Tanks and low pressure vessels that cannot accumulate above 15 psig.
2. Non-code building service or heating water surge tanks under 50 gallons.

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<sup>15</sup> Gloveboxes should be protected from over pressurization with bubblers or other pressure relief device which exits through a vent system. Glove failure (popping off), window seal failure, or other such failures are not acceptable pressure relief methods. Glovebox design is covered by ESM Ch 6, LANL Master Spec 11 5311.08, AGS-G001, etc.

<sup>16</sup> Guidance on vacuum system design can be found in American Vacuum Society publications.

3. Although not specifically included by the requirements of 10 CFR 851, vessels regulated by the Department of Transportation (DOT)<sup>17</sup> must follow the recertification frequency intervals as defined in this document.
  - a. Relief valves attached to such DOT vessels must follow the test/replacement schedule as defined in this document.
  - b. DOT vessels are not required to be entered into MEL or CMMS (If the DOT vessel is permanently installed in the system, refer to section 11.C.)
  - c. DOT vessels must be maintained within inspection interval dates.<sup>18</sup>
4. Pressure vessels in vehicle pneumatic and hydraulic systems.
5. Drained, depressurized, and vented out-of-service pressure systems that are so labeled.
6. Self-Contained Breathing Apparatus (SCBA) air cylinders.
7. Portable eyewash stations and non-refillable, portable cylinders, and soda and syrup containers covered by NSDA (National Soft Drink Association) or applicable Parts of Title 49 of the Code of Federal Regulations.
8. Excluded vessels that are utilized in vapor condensation processes must have appropriate vacuum breathing mechanisms to prevent vessel collapse from the resulting vacuum, or be designed to withstand the associated forces.

**NOTE:** The following vessels cannot be excluded without acceptance by the CPSO or delegate through the variance process:

1. Any vessel that is either permanently or temporarily connected to a pressure source (e.g. gas cylinder or dry ice) that is greater than 15 psig, or that can pressurize the volume to greater than 15 psig.
2. Pressure containers that rely solely on interlocks to limit the pressure to less than 15 psig<sup>19</sup>
3. Vacuum vessels that can be internally pressurized to greater than 15 psig.

### C. Excluded Pressure Relief Devices

1. Rupture disk and fusible plugs on DOT gas cylinders.
2. Pressure relief devices on vehicle pneumatic and hydraulic systems.
3. Pressure relief devices on drained, depressurized, and out-of-service vessels.
4. Non-metallic, non-Code pressure relief valves on portable eyewash stations that comply with the NSDA standard.

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<sup>17</sup> Relief valves on DOT vessels are not excluded from this program, and must be maintained as defined in this document. Vessels must be within their inspection date as defined in the DOT, UN/IM section of this document.

<sup>18</sup> A cylinder may be requalified at any time during or before the month and year that the requalification is due. However, a cylinder filled before the requalification becomes due may remain in service until it is emptied (49CFR180.205).

<sup>19</sup> See Code Case 2211 and ASME Section VIII, Division 1, Part UG-140

5. Fusible plugs on refrigeration equipment that conforms to ASHRAE 15.
6. Pressure relief devices that do not provide a pressure protection function.
7. Pressure relief devices on transformers.
8. Hydrostatic bubblers, e.g., on gloveboxes.

#### D. Excluded Calculations

1. Design calculations are not required for package systems (e.g. boilers, air-compressors, or hydraulic power units) built by a reputable manufacturer that are not of unique design, with a retrievable model number. Such package units must be readily found in a catalog, or manufacturer's inventory, with proven design reliability. However, manufacturers data reports (e.g. U-1, U-1A), and system drawings (to include schematics) must be maintained in the pressure system documentation package.
2. Modification or an alteration to the above package systems voids this exemption. Drawings must be updated, and calculations must be performed to prove compliance with the applicable code.

## 8.0 System Identification Tag

### A. System Identification and Inventory Method

1. Certified pressure systems must be marked with the following system identification tag, which will be supplied by the CPSO. Legacy pressure systems which have been walked down by the pressure safety team and are in the process of becoming certified in accordance with the implementation timeline will also be marked with the identification tag. This tag is not meant for identification of pressure vessels or other pressure system components. It is a system identification and status tag.
2. The purpose of this tag is to provide a means of identification (inventory) and status of the system. The identification number on this tag must match the pressure system documentation package identification number. This system identification number is unique to each individual system.  
*Guidance: The tag should be attached using stainless lock-wire or zip-ties anywhere on the system in open view, where the most visible portion of the pressure system is located. To be attached by the PSO or designee.*
3. Tags must not be placed on removable components such as gas cylinders. Further, tags may not be removed from the system without notifying the CPSO.
4. Tag indicates system status, inventory number, and certification date. Does not indicate vessel inspection due date, or relief device due date.
5. Status indication "stickers" may only be generated by CPSO-approved method (i.e., system owner may not print their own "stickers"). System certification dates will be tracked through the certification tracking database.
  - a. "Inactive" stickers must be issued for those pressure systems that have been removed from the pressure source, are not designated to be disassembled, and are considered to become operational in the future. Inactive systems must be physically disconnected from the pressure source.
  - b. "Active" stickers must be issued for those pressure systems that have been certified and approved to operate as per the requirements of this document.

*Guidance: "Stickers" should be covered with UV-resistant tape such as Kapton® or other similar transparent, UV-resistant tape, after being applied to the identification tag.*

- c. Damaged or lost stickers can be replaced through request to the CPSO, who will verify certification status in the pressure systems database prior to issuing a new sticker.

## SYSTEM IDENTIFICATION AND CERTIFICATION TAG



### STICKER EXAMPLES

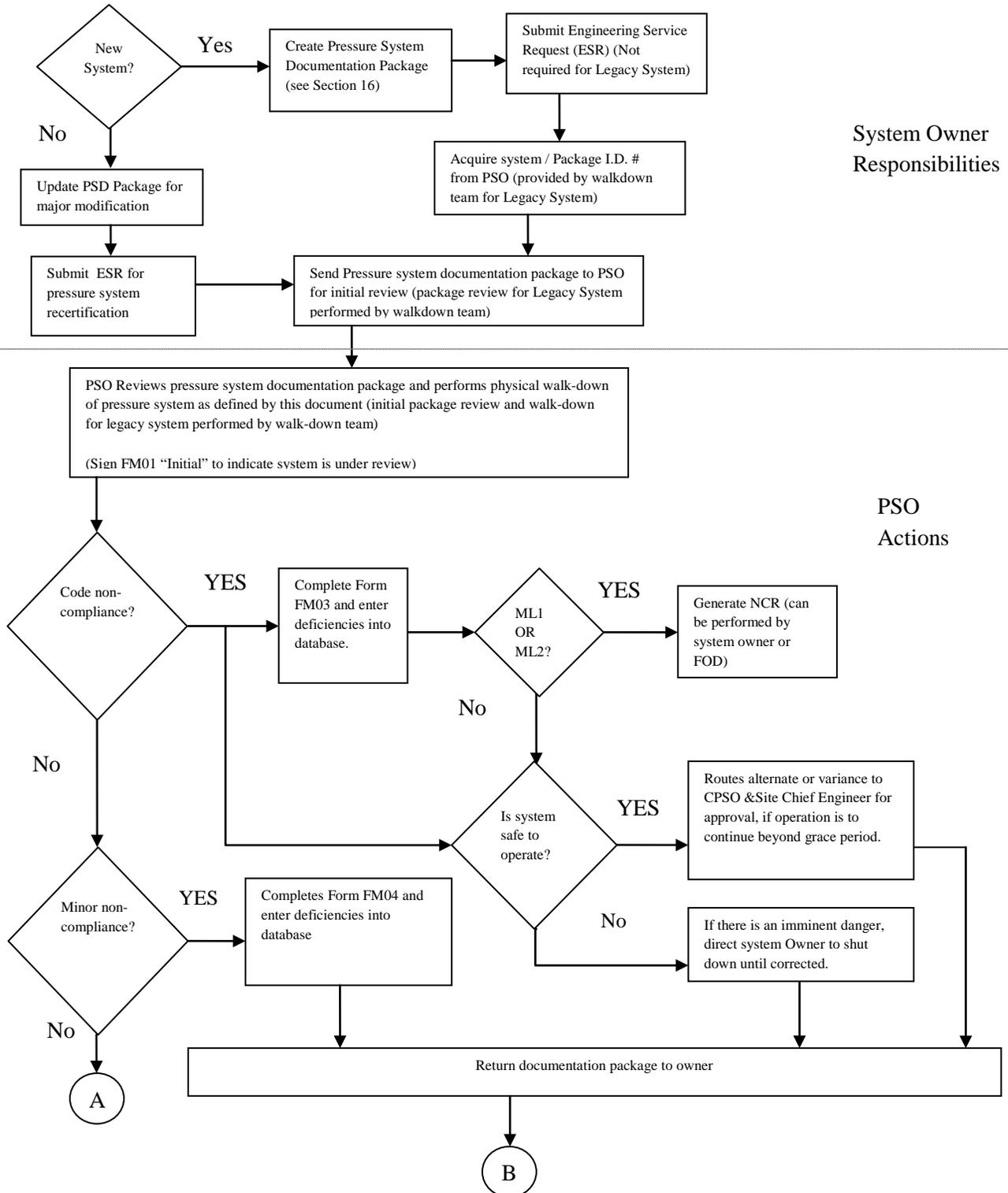
<b>ACTIVE</b>	<b>INACTIVE</b>
INSPECTION DATE _____	INACTIVE DATE _____
DUE DATE _____	
CERTIFYING PSO _____	CERTIFYING PSO _____

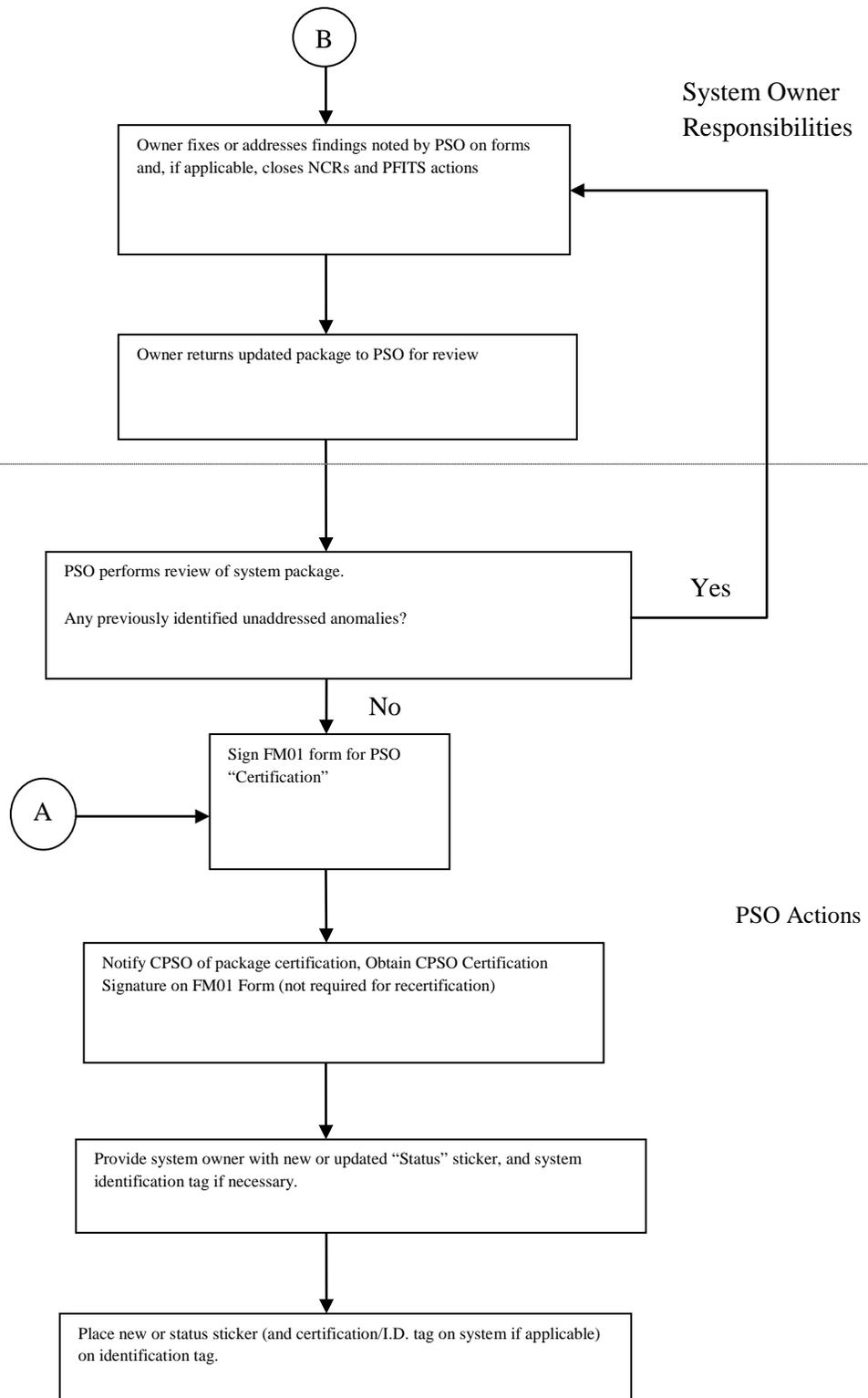
### **B. System Relocation/Disassembly Notification Process**

1. If a pressure system is to be disassembled and relocated on laboratory property, notify the CPSO so that the pressure system tracking database can be updated for the new location.
2. If a pressure system is to be relocated off LANL property, notify the CPSO so that the system can be removed from the pressure system tracking database.
3. When a system is to be disassembled and removed from service, notify the CPSO so that the pressure system tracking database can be updated to indicate that the system has been removed from service.

### 9.0 Pressure System Certification Process

#### A. Process Flow Chart





**B. General**

1. The certification process is a formal review of pressure systems by the PSO. The program also includes recertification of a pressure system if a major modification is performed to ensure continued compliance with the program (e.g., configuration control, documentation accuracy, and compliance with the codes). It is not an ASME certification. It is merely a permit granted by the CPSO which authorizes the pressure system to be operated. Pressure systems credited in a safety basis document may have additional operability requirements.
  - a. Formal certification of a pressure system produces a documentation package. This package is a record document and must be maintained subject to accepted practices for configuration management<sup>20</sup>.
  - b. All major modifications (see Definitions) to pressure systems must be documented and documentation must be maintained current. PSO must approve re-certification prior to placing the modified system back in service.-
2. New pressure systems must not be operated until certified.
3. If deficiencies are found during the review/certification process (or any other time), they must be identified on Form FM03 and FM04, as applicable (see attached forms for examples).
4. Whenever code non-compliance deficiencies are found on ML-1 or ML-2 systems, the PSO or system owner must initiate a Nonconformance Report (NCR) when required by LANL Procedure [P 330-6](#).
5. *Code non-compliances requiring hardware modification in operating systems should be addressed in accordance with PD322.*
6. Existing pressure systems must be evaluated to the latest revision of this document and the code of record of the system's construction (COR defined in ESM Ch 1 Z10). *If original code or standard is unavailable, newer editions may be used.*
7. Inactive, deactivated, or other non-active pressure systems may not be operated in order to achieve active status (e.g., perform leak checks) until after the PSO has reviewed the system design, configuration, and documentation package.
8. The CPSO will review and, if acceptable, approve any deviations from this Chapter along with Site Chief Engineer per ESM Ch. 1 Section [Z10](#). Deviation approvals must be documented in the pressure system documentation package.
9. Any system found to be out of compliance with this document or found to be in an unsafe configuration in the opinion of the PSO must be reported to the system owner and the FOD. Upon direction from the PSO, the owner must fix any anomalies found by the PSO prior to certification as defined in this section. Deficiencies in existing (legacy) systems will be addressed in accordance with Section 10.0.

**C. Preparing a Pressure System for Certification**

1. Design information requested within this section and listed in Tables 16-1 and 16-2, where appropriate, may alternatively be contained in other documents or in controlled

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<sup>20</sup> Refer to DOE-STD-1073-2003, Configuration Management

databases, such as the Master Equipment List (MEL) or Computerized Maintenance Management System (CMMS), but must be referenced and readily available for review. The record must be managed per LANL P1020, P1020-1, and P1020-2.

2. If system is new, system owner ensures system is constructed and tested in accordance with the requirements of this ESM chapter, and applicable ASME Codes.
3. System Owner ensures that required forms and quality documents are placed and maintained in the pressure system documentation package and the package is identified by the identification number given by the PSO, as generated by the certification tracking system database.
  - a. See Tables 16-1 and 16-2, Documentation Requirements Tables, in Section 16 of this document for required documentation that needs to be maintained and kept updated in the pressure systems documentation package.
  - a. Applicable forms in this document must be completed and placed into the pressure systems data package.
4. System Owner requests a System and Documentation Package review from a PSO.  
**WARNING:** No new pressure system may be operated until CPSO has certified its design.
5. The PSO reviews the pressure system documentation package and performs a system walk down, as follows:

*NOTE: The PSO (or system reviewer) should also look for any hazards that may exist in the system design such as: material incompatibility, non-intrinsically-safe electrical components near flammable chemicals or gases, inadequately braced lines, etc. Such observations or concerns must be noted and accounted for in the reviewer's write up.*

- a. Identifies any Minor Non-compliances on form FM04, "Minor non-compliance".
  - b. Identifies any Code Non-compliances on form FM03, "Code non-compliance".
  - c. Reviews and approves the Documentation Requirements per Tables 16-1 for legacy systems, or 16-2 for new systems.
  - d. The pressure system documentation package is checked and verified for accuracy.
  - e. The actual pressure system is walked down to verify accuracy of package contents.
  - f. Completes (signs and dates) forms FM03 and FM04, and then inserts the forms into the pressure system documentation package.
  - g. PSO or system owner generates NCRs if required by Para. 9.0.E, below.
  - h. PSO signs FM01 "Pressure System Certification Status Form" (Initial Review) and returns the documentation package to the System Owner.
6. System Owner updates the documentation package and modifies the pressure system based on PSO review and comments identified on forms FM03 and FM04.

7. System Owner submits package back to PSO for second review.
8. If the documentation package and pressure system is acceptable, the PSO then signs the Pressure System Certification Status Form, FM01, and delivers the package to the CPSO for final review and approval.
9. If the system is code compliant, the CPSO, or designee, then certifies the system as “Active” by signing the Pressure System Certification Status Form (Form FM01) and updating the certification tracking database.
  - a. The PSO issues the Active sticker and, if necessary, the Identification Tag to the System Owner if system is not already tagged.
  - b. The System Owner attaches the sticker to the Identification Tag and, if necessary, installs the Identification Tag on the pressure system.
  - c. Package stored in IRM repository designated by FOD.

**D. Conflict of Interest**

1. If a PSO owns or uses pressure systems, they may not review or approve their own systems. They must be reviewed by an uninvolved PSO.

**E. Documenting Non-conformances**

1. Forms FM03 and FM04 must be completed for all deficiencies. In addition, non-conformances arising from deficiencies or indeterminate conditions for ML-1 and ML-2 systems (at a minimum) are documented on non-conformance reports (NCRs).
2. A copy of the NCR (Form 2082) should be maintained in the system documentation package.

**F. Deactivating a Pressure System**

1. The responsible System Owner safes the particular pressure system which includes:
  - a. Removing hazardous materials from the system.
  - b. Reducing system pressure to ambient
  - c. Disconnecting the system from all pressure sources.
2. The PSO reviews the system and if the deactivation is acceptable updates the certification tracking database with date of deactivation.
3. The PSO submits note into pressure system documentation package that system is not active, and maintains package in IRM document control repository.
4. The PSO annotates the Pressure System Certification Status Form with the date the system became inactive and places the “Inactive” sticker on the system identification tag.
5. PSO informs the CPSO that the pressure has been deactivated, and inactivates the related components in CMMS (“PassPort”).
6. CPSO or delegate updates certification tracking database showing the system as inactive.

7. If system is to be disassembled perform the following:
  - a. Notify IRM that documentation may be archived.
  - b. The database tracking system entries must be archived.
  - c. The identification tag must be returned to the PSO.

## **10.0 Pressure System Deficiency Disposition Requirements for Existing Pressure Systems**

- A. This Section is for systems with known successful operating experience, and is intended to allow continued use of currently operating systems with a graded approach to risk reduction. New systems and components must meet all Code and ESM requirements.
- B. If a deficiency is identified which constitutes an imminent danger, the system shall be immediately placed in a safe configuration.
- C. If the disposition of a deficiency requires a hardware modification, then that disposition should be tracked by the CPSO or delegate in accordance with PD322.
- D. Risks are binned in three levels; examples are shown in Table 10-1 below.

Table 10-1 Deficiency Risk Level Bins

Risk Level 1 High Risk	Risk Level 2 Moderate Risk	Risk Level 3 Low Risk
RL1-A. Missing pressure relief device <sup>21</sup>	RL2-A. Vessel pressure rating indeterminate (unknown MAWP)	RL3-A. Missing weld examination documentation, if required
RL1-B. Component, piping, or vessel known to have a MAWP less than the relief device set point	RL2-B. Piping component pressure rating indeterminate (unknown MAWP)	RL3-B. Missing pressure test documentation
	RL2-C. Relief device sizing or set point choice indeterminate (missing calculation)	RL3-C. Missing piping flexibility or piping support analysis, if required
	RL2-D. Vessel or pressure relief device maintenance overdue	
	RL2-E. Missing or inadequate piping supports or restraints	

- E. For the risk category examples in the table above, perform the following corrective actions (graded by FS category).<sup>22</sup> Along with the corrective actions identified below, grace periods are provided which define the time frame during which the corrective action is to be implemented. Longer grace periods may be granted by the CPSO on a case-by-case basis using the variance process.

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<sup>21</sup> Unless device is not required per ASME Code Case 2211 and/or ASME Section VIII, Division 1, Part UG-140. Information required by the UG-140 analysis may be documented in various formats, but must be referenced and readily available for review. The evaluation shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2

<sup>22</sup> Replacement of indeterminate components with new ones fully meeting requirements is always allowed and is the preferred approach, but must be balanced with operational/cost needs, thus this graded approach.

Risk Level 1 -- High

	<p>RL1-A. Missing pressure relief device</p> <p>RL1-B. Component, piping, or vessel known to have a MAWP less than the relief device set point</p>
FS1- FS3	<p>Implement compensatory measures and/or the system will be placed in a safe configuration as soon as practical and promptly correct deficiency</p> <p>Grace Periods: With regard to the requirement to resolve this level of deficiency “as soon as practical”, the expectation is that the FOD will prepare and submit a risk-based corrective action plan for approval by the Chief Pressure Safety Officer and the Site Chief Engineer, using the alternate method/variance process.</p>

- F. The tables below provide standard/default dispositions for Risk Level 2 and 3 deficiencies. Alternatively, for these deficiency bins and where explicitly authorized below, a risk-based engineering evaluation may be performed in accordance with Appendix E to establish the required corrective action. These evaluations must be performed by a qualified design engineer (see Section 3.0.A) and approved by a qualified pressure safety officer (see Section 3.0.C).

Risk Level 2 -- Moderate

	<p>RL2-A. Vessel pressure rating indeterminate, or non-ASME stamped vessel without design documentation (unknown MAWP)</p>
FS1	<p>Perform calculations as defined by the ASME Section VIII to establish MAWP or replace with a code-stamped vessel</p>
FS2	<p>Perform calculations as defined by the ASME Section VIII to establish MAWP or replace with a code-stamped vessel, or install shielding to protect personnel</p>
FS3	<p>Perform calculations as defined by the ASME Section VIII to establish MAWP, or replace with a code-stamped vessel, or install shielding to protect personnel</p>
<p>Grace periods: FS1: 40 working days; FS2: 80 working days; FS3: 120 working days</p>	
<p>Risk-based engineering evaluations may be applied for FS3 deficiencies</p>	

	RL2-B. Piping component pressure rating indeterminate, or unlisted piping component (unknown MAWP)
FS1	Perform calculations as defined by the code to establish MAWP or replace with a listed component
FS2	Perform calculations as defined by the code to establish MAWP <u>or</u> perform code pressure test (i.e., hydrostatic or pneumatic test) based on system design pressure (CPSO or designee to approve test pressure), or install shielding to protect personnel
FS3	Perform calculations as defined by the code to establish MAWP <u>or</u> perform code pressure test (i.e., hydrostatic or pneumatic test) based on system design pressure (CPSO or designee to approve test pressure), or install shielding to protect personnel
Grace periods: FS1: 40 working days; FS2: 80 working days; FS3: 120 working days	
Risk-based engineering evaluations may be applied for FS2 and FS3 deficiencies	

	RL2-C. Missing relief device calculation
FS1- FS3	Perform calculation and take appropriate corrective action, if required
Grace periods: Relief valve calculations are being performed by the pressure safety implementation project, when information becomes available from the walkdown teams. The prioritization is risk-based, with the FS1 system calculations being performed first, followed by the FS2 and then the FS3.	
Risk-based engineering evaluations may not be applied for this category of deficiency	

RL2-D. Vessel or relief device maintenance overdue		
Grace Period for Removal from Service (or Variance Approval) as a Percentage of Required Maintenance Interval (Para. 13.0.D) <sup>23</sup>		
	Non-corrosive Service	Corrosive Service
FS1	150	110
FS2	175	125
FS3	200	150
Risk-based engineering evaluations may be applied to extend the grace period, but not to eliminate requirement to perform maintenance		

RL2-E. Missing or inadequate piping supports or restraints	
FS1- FS3	Install required pipe supports
Grace periods: FS1: 40 working days; FS2: 80 working days; FS3: 120 working days	
Risk-based engineering evaluations may not be applied for this category of deficiency	

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<sup>23</sup> Once any required PM has been performed on a component, that PM must be performed on the required maximum interval thereafter (no grace period), and missed PMs will require an approved variance to continue operation. These percentages were created to allow a reasonable period to eliminate the sizeable maintenance and inspection backlog with a risk-based graded approach; they will be deleted from the program once that backlog is eliminated.

Risk Level 3 -- Low

	RL3-A-inside. Missing weld examination documentation ( <b>within a glove box</b> <sup>24</sup> ) – Refer to Table 10-2 for code weld examination requirements for full penetration welds
FS1	Perform code pressure test (CPSO to approve test methodology)
FS2	Perform in-service leak test (CPSO to approve test methodology and test pressure)
FS3	Not applicable
Grace periods: FS1: 120 working days; FS2: 160 working days; FS3: N/A	
Risk-based engineering evaluations should be applied for FS1 and FS2 system deficiencies to determine if further action is required	

	RL3-A-outside. Missing weld examination documentation ( <b>outside a glove box</b> ) – Refer to Table 10-2 for code weld examination requirements for full penetration welds
FS1	Perform code weld examination (or other sampling methodology or technique as approved by CPSO)
FS2	Perform code weld examination (or other sampling methodology or technique as approved by CPSO)
FS3	Not applicable
Grace periods: FS1: 120 working days; FS2: 160 working days; FS3: N/A	
Risk-based engineering evaluations should be applied for FS1 and FS2 system deficiencies to determine if weld examination is required	

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<sup>24</sup> Or other inaccessible location. Could also apply to non-toxic systems behind a barrier that protects personnel.

**Table 10-2 Weld Examination Requirements for Full Penetration Welds**

ASME B31.3 Weld Examination Requirements (full penetration welds)			
FS3 Category D	FS2 Normal	FS1 Category M	FS1 High Pressure
None	Volumetric examination (RT or UT) of 5% of welds	Volumetric examination (RT or UT) of 20% of welds	Volumetric examination (RT or UT) of 100% of welds
ASME B31.1 Weld Examination Requirements (full penetration welds)			
	All others	Temperatures between 350°F and 750°F and pressures above 1025 psig	Temperatures over 750°F and all pressures
	None	Volumetric Examination (RT or UT) for over NPS 2 and wall thickness over ¾ inch; Visual Examination for all sizes with thickness ¾ inch or less	Volumetric Examination (RT or UT) for over NPS 2 and Surface Examination (PT or MT) for NPS 2 or less
ASME B31.9 Weld Examination Requirements (full penetration welds)			
Nondestructive examination is not required for legacy pressure systems that fall within the scope of ASME B31.9, Building Services Piping			

Note: If a piping code other than ASME B31.1, B31.3, or B31.9 is applicable, the CPSO will provide the appropriate weld examination requirements.

	RL3-B. Missing pressure test documentation
FS1	Perform code pressure test (e.g., hydrostatic or pneumatic test) based on system design pressure (CPSO or designee to approve test methodology and test pressure)
FS2/ FS3	Perform in-service leak test (CPSO to approve test methodology and test pressure)
Grace periods: FS1: 120 working days; FS2: 160 working days; FS3: 200 working days	
Risk-based engineering evaluations may be applied for FS2 and FS3 system deficiencies	

	RL3-C. Missing Piping Flexibility or Piping Support Analysis, if required
FS1-FS3	Perform code compliant analyses and take appropriate corrective action, if required (see Section 11.0.R of this Chapter)
Grace periods: FS1: 120 working days; FS2: 160 working days; FS3: 200 working days	
Risk-based engineering evaluations may be applied for FS2 and FS3 system deficiencies	

- G. Generic risk-based engineering evaluations have been prepared for the system categories listed below. These evaluations are available on the Pressure Protection Program website and should be consulted for applicability prior to preparing an evaluation for a specific system.
  - 1. Compressed air systems
  - 2. Inert gas cylinders
  - 3. Low pressure steam and condensate

- H. Alternate Method/Variance Approval
  - 1. Approval of an alternate method or variance can occur under the following circumstances:
    - a. To permit continued operation prior to correction of deficiencies
    - b. To permit a long-term operation with a condition that deviates from this document.
  - 2. Approval is requested per ESM Chapter 1 Section Z10. System Owner must submit a Conduct of Engineering Request for Variance or Alternate Method, LANL Form [2137](#), ideally using the ES Division [Engineering Service Request](#) System available from ES-Div homepage.
  - 3. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.<sup>25</sup>
  - 4. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10 CFR 851.

## 11.0 Design and Documentation

### A. Calculations

- 1. Calculations and documentation must be performed/provided using U.S. customary units (psi, inches, gpm, scfm, °F, lbs, etc.).<sup>26</sup>
- 2. Calculations, including welding calculations, must be performed per [AP-341-605, Calculations](#), and ESM Chapter 1 Section [Z10](#) (re: Design Output Documentation) and must be maintained in the pressure system documentation package.

<sup>25</sup> On 8/14/09, LASO and LANL agreed that LASO would be copied on all LANL approved variances associated with FS1 systems. Further, LASO will be copied on all LANL approved variances associated with Safety Class or Safety Significant systems, regardless of the fluid system category (Ref: “Pressure Safety at WETF....Nuclear Facilities,” Email, J. Vozella to K. Carr et al, 8/14/2009). Additionally, LASO will be notified of any deficiencies discovered in Safety Class or Safety Significant systems.

<sup>26</sup> Relief devices are rated in US units; eliminates conversion errors.

3. Relief devices on new systems (other than Excluded) must have sizing calculations performed showing that the capacity of the designated relief device maintains system pressure at or below 110% (or other percentage defined by ASME Section VIII, Div 1 Part UG-125) of the system MAWP.<sup>27</sup>

*Guidance:* A FileMakerPro program is available to perform relief device sizing calculations, as is training material on the process to be followed, [here](#). MathCAD shell also available.

4. Where system flow characteristics cannot be determined through calculations, capacity of the relief system must be verified by performing an in-place flow test of the relief devices upon completion of fabrication as defined in ASME PTC-25 paragraph 4.3.3 and API 521 for pressure systems with supplied pressure. Flow test must be documented and maintained in the pressure system documentation package.

**Note:** Any existing pressure system that does not have sizing calculations on relief devices must either perform and document an in-place flow test for existing relief valves, or generate flow capacity calculations. The calculated relieving capacity of pressure relief systems utilizing rupture disks as the sole relief device must not exceed a value based on ASME BPVC Section VIII Division 1, Part UG-127 (a)(2).

#### B. Cryogenic Systems

1. For systems using ball valves, the ball must have a pressure relief hole designed into the ball to prevent over pressurization inside the ball cavity due to thermal expansion when the valve is in the closed position.
2. All valves and components must be designed and approved for use by the manufacturer for cryogen media.
3. Polymer-lined flexhoses must not be used.<sup>28</sup>
4. Flexibility analysis (as defined in the most applicable piping code)<sup>29</sup> must be performed on rigid piping to ensure adequate strain relief is designed into the assembly due to thermal contraction.
5. Soft goods in components must be compatible with the cryogen fluid, and be suitable for both the temperature and pressure. (Example: Many PTFE material combinations are compatible with hazardous fluids, yet maintain a seal at cryogenic temperatures, at different pressure ranges).

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<sup>27</sup> See ASME Section I and IV for boiler-specific capacity allowances

<sup>28</sup> The extreme low temperatures will cause the hoses to become brittle, increasing the risk of rupture and leakage

<sup>29</sup> For example, see B31.9 Chapter 2 Part 5 or ASME B31.3 Paragraph 319.

**C. DOT Vessels**

1. DOT vessels that are greater than 6" I.D. and are permanently installed in a pressure system must either maintain their DOT inspection intervals or, if it cannot be removed for recertification, must be evaluated as ASME equivalent as follows:
  - a. The material specification of the vessel must be determined as listed in the appropriate 49 CFR 178.xx cylinder specification (e.g., material specification for a 3A cylinder is listed in 49 CFR 178.36)
  - b. Using the appropriate maximum allowable stress for the material (at temperature) found in ASME BPVC Section II, Part D (matching the material specification of the DOT Cylinder).
  - c. Perform the ASME pressure calculations as described in Section VIII, Div 1, Part UG-27 or UG-28 as appropriate.
  - d. Maintain a copy of the calculations in the pressure system documentation package indicating the vessel's revised MAWP rating.
  - e. The vessel must be entered into CMMS and must be periodically inspected per the appropriate internal and external inspection intervals.
2. All other DOT vessels must maintain their inspection and certification intervals, with the due date of certification clearly identified on the vessel.

*Guidance:* Vessels less than 6" ID are considered piping components, not pressure vessels.<sup>30</sup>

**D. Drawings and Sketches**

1. Design information requested within this section, where appropriate, may alternatively be captured in other documents or in controlled databases, such as the Master Equipment List (MEL) or Computerized Maintenance Management System (CMMS), but must be referenced and readily available for review. The documents shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2.
2. At a minimum, non-excluded pressure systems must have accurate system schematics providing information of fluid flow paths, and system interactions of all wetted/pressurized components in the fluid path.
3. System schematics must ultimately be in accordance with ESM Chapter 8, Appendix I, "PFD and P&ID Diagrams." PRV sizing calculations may be performed from accurate, dimensioned sketches.
4. Drawings and sketches must comply with [AP-341-608](#), Engineering Drawings and Sketches.
5. Fluid components must be identified using the identification system established in ESM Chapter 1, [Section 200](#), "Numbering and Labeling".
6. Diameters, wall thickness, and material type of all tubing and piping used in the system must be shown.

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<sup>30</sup> ASME B&PV Code Section VIII (e.g., Div 1, UG-1)

7. Sketches specific for relief device calculations must show all dimensions required to generate the calculation.
8. Pressure safety devices: Maximum pressure setting must be shown. Note that the actual setting of the device in the system may be lower than the drawing maximum set point.
9. Pressure regulators: The following must be shown on the system schematic:
  - a. Maximum operating inlet pressure, and operating outlet pressure (not to be confused with MAWP)
  - b. Pressure regulator (Cv) flow rate coefficient is not required to be shown when a smaller orifice is installed upstream or immediately downstream of a pressure regulator, or when tubing I.D. before (or immediately after) the regulator is less than regulator flow area. It is good practice to show Cv in these cases.
10. Pressure gages and transducers: Pressure range must be shown. This is not to be confused with MAWP.
11. Vessels: MAWP as rated by ASME code stamp or alternative calculations based on wall thickness evaluation must be shown.
12. System MAWP including new MAWP downstream of a pressure-controlling component must be shown.
13. Inside diameter of orifices must be indicated.

#### **E. Finite Element Analysis and Other Software**

1. Use of computer software (e.g., Cosmos, NASTRAN, Pro/Mechanica, Ansys, Algor, custom shells, etc.) to perform analysis of pressure systems and components is acceptable in performing engineering calculations; however, software must be verified and validated as defined in DOE O 414.1C (or later), *Quality Assurance*, including use within established bounding conditions and on operating systems for which the specific release (version) was tested.
2. Finite element analysis and computer calculations must follow ESM Chapter 1 – General, Section [Z10](#) on “Design Output Requirements”.

#### **F. Fitting and Fastener Assembly**

1. Must comply with one of the following
  - a. Manufacturer standards based on the joint design and all materials of construction.
  - b. A published specification or controlled standard
  - c. Special calculations by the designer

#### **G. Flexible Hoses and Tubing**

1. All preassembled flexible hoses must be procured from the manufacturer with the MAWP stamped, etched, or tagged on the hose or end connectors indicating the maximum allowable working pressure of the assembly.

2. Flexible hose assemblies without manufacturer's MAWP indicated on the hose/flexible tubing must not be used on non-excluded pressure systems.
3. Hoses used for cryogenic service must be convoluted stainless steel or specifically designed for such service.
4. Long flexible hoses must be restrained every six feet, and/or at every connector where multiple flexible tubing/hoses are connected in series.
5. Consider material compatibility per NFPA 30 and 45
6. Flexible "poly-flo", plastic and rubber hoses/tubing must not be used for the conveying of flammable gases and flammable liquids per NFPA 30 27.3.1 and NFPA 45 10.2.
7. "Poly-Flo" or similar non-metallic tubing must comply with ASME B31.3, Chapter VII.
8. Flexible hoses must be installed and used in such a manner as to prevent kinking and to minimize torsion, axial loads, twisting, and abrasion.

#### H. Fluid Category Determination

1. The CPSO must make the final determination of fluid category for all systems if there is any question. Determination of fluid category must be determined using ASME B31.3 (e.g., Appendix M, Figure M300).
2. A piping system will be considered "High Pressure Fluid Service" and must meet the requirements of ASME B31.3 Chapter IX if the design pressure is in excess of that allowed by the ASME B16.5 Class 2500 flange rating for the specified design temperature and material group. See High Pressure in Definitions section of this document for additional information.
3. Pressure systems (including repairs or alterations) with fluids identified as "lethal substance" must comply with the following:
  - a. Pressure vessels must be designed and constructed per ASME Section VIII "lethal substances."
  - b. Piping systems will comply with the code by using the flow chart (Figure M300 from ASME B31.3) to determine fluid media requirements (Category M vs. Normal). See listing in Appendix F of this document.
4. Systems designated as Category M fluid service must be designed and tested per ASME B31.3, Chapter VIII, "Piping for Category M Fluid Service."
5. For further guidance see LANL's "B31.3 Process Piping Guide," ESM Chapter 17 Section [D20-B31.3-G](#).

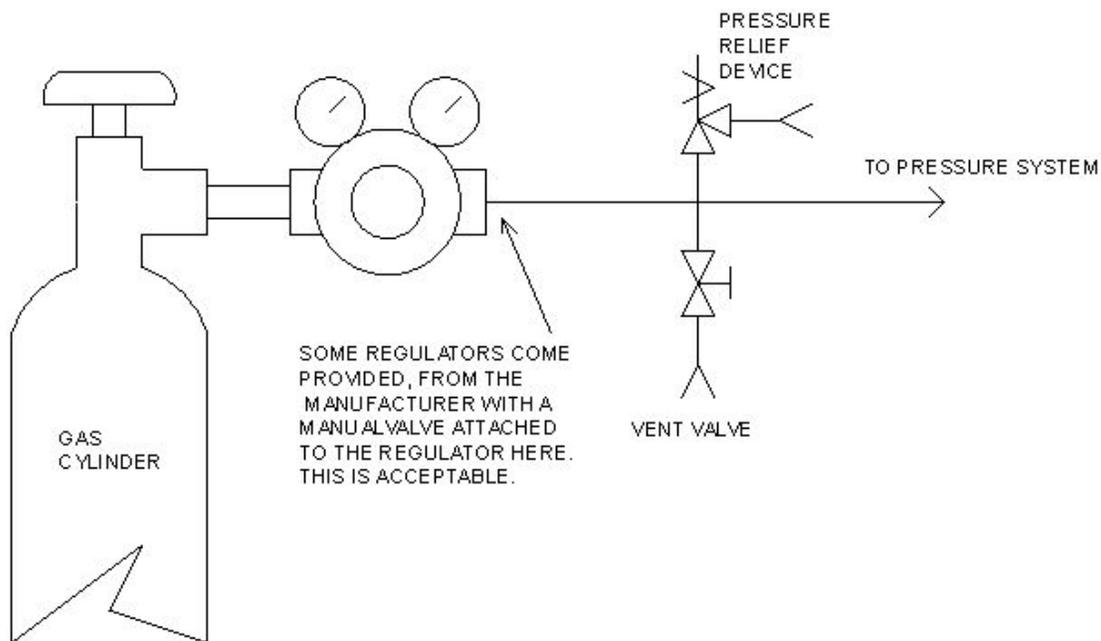
#### I. Gas Cylinder Pressure Systems

1. Pressure systems utilizing pressurized cylinders as the pressure source must meet all the applicable requirements of this document, including certification.<sup>31</sup>

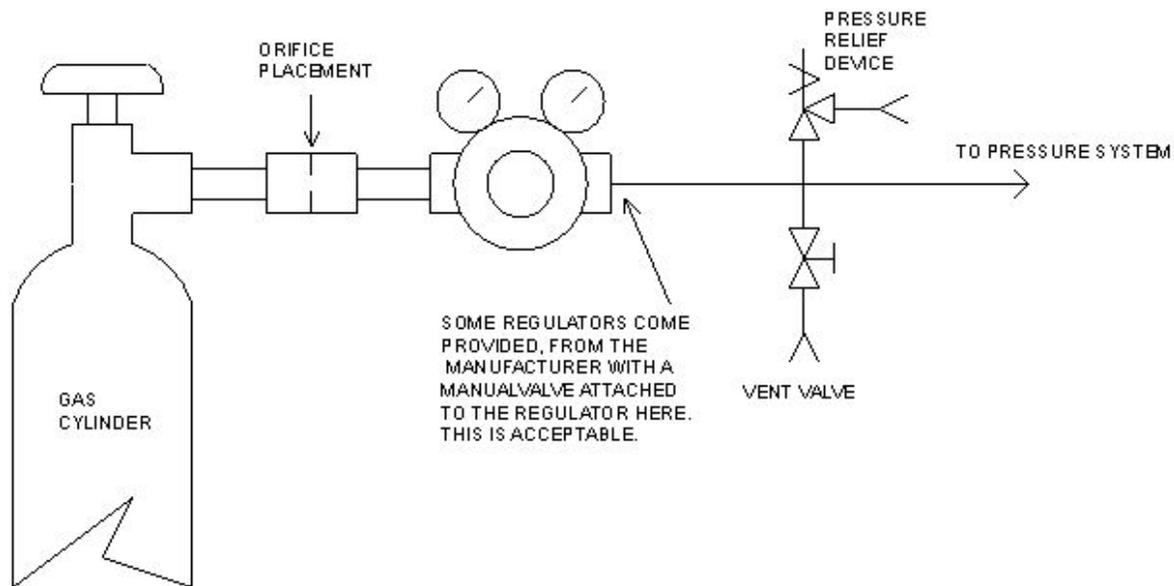
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<sup>31</sup> ASME B31.3 does not apply to gas regulators, and regulators are not required to be evaluated against requirements associated with unlisted components. For pressure system evaluation purposes, the gas regulator manufacturer's inlet pressure rating or range shall be considered the gas regulator MAWP.

2. Pressure relief devices incorporated integrally into the design of pressure regulators do not perform a pressure protection function for downstream components, and must not be considered as sufficient pressure relief.
3. Cylinders must be braced, chained, in place to prevent toppling.
4. Gas cylinders must have a pressure safety manifold system incorporated into the design after the regulator as shown below:



5. The following illustration shows the placement of a flow reducing orifice on a gas cylinder system which is used to reduce the mass flow rate from the gas cylinder so that the down stream (undersized) pressure relief device is not overwhelmed if the pressure regulator fails. Use of orifices is not required, provided the pressure relief device and regulator are matched appropriately during the design process.



6. Where specific flow requirements are not a required function of the fluid flow, the installation of flow-reducing orifices is highly recommended to slow the flow rate of gas caused by failure of a regulator, or operator error.
7. Open flow systems (e.g., purge systems) that are not designed for and cannot accommodate full bottle pressure/flow rates must utilize flow reducing orifices.
8. Pressure systems that are not "open flow" at all times, but require the use of RFOs, must have appropriate pressure relief installed in the appropriate location(s) in the pressure system.
9. Pressure systems that are designed in accordance with the applicable ASME code that are capable of withstanding the full gas cylinder pressure are not required to have pressure relief. Such cases must be proven to be designed per the ASME code, and must be evaluated against ASME Section VIII, Division 1, Part UG-140. Such applications must be reviewed by the CPSO.
10. Guidance for selection of pressure relief devices for gas cylinder pressure systems is provided in Appendix D.

#### J. Hydrogen and Flammable Fluid Pressure Systems

1. Pressure systems containing such fluids must be designed and evaluated against the requirements of ESM Chapter 10, *Hazardous Processes*, and its appendices.
2. Systems containing hydrogen must be evaluated for hydrogen embrittlement.
3. Bonding and grounding must be evaluated for storage vessels and systems containing such fluids.
4. Electrical components (solenoid valves, power strips, electrical control cabinets) must be intrinsically safe when required by the NEC.

**K. Instruments**

1. When a manufacturer's published operating range is equal to, or greater than, the design pressure of the system, the instrument shall be considered as meeting the requirements of 10 CFR 851.
2. When manufacturer's published operating range does not bound the design pressure, then safeguarding shall be applied to instruments to provide an equal level of protection in accordance with 10 CFR 851. These safeguards shall be in order of precedence: 1) engineering controls, 2) administrative controls, 3) personnel protective equipment.
3. Pressure and Vacuum Gauges: Overpressure relief protection must be provided on bourdon-tube, dial-indicating pressure gauges that operate at pressures greater than 15 psig by one of the following means:
  - a. Pressure gauges approved by Underwriters Laboratories (UL) in accordance with UL-404, "Standard for Gauges, Indicating Pressure, for Compressed Gas Service" Standard for Safety is acceptable.
  - b. Tempered safety glass or plastic face or shield meeting the requirements of ANSI Z97.1, and a blowout back or plug for pressure relief.
4. Pressure gauges that serve primarily a pressure indication for over pressure protection (i.e., not used for process data collection) must have a range of at least 1.25 times, but no more than twice the set pressure of the relief device as recommended in ASME Section VIII, Div. 1, Appendix M, Para. M-14.
5. MAWP should be known. This value is typically greater than the dial indicator range.

**L. Labeling and Tagging of Components**

1. Components in a pressure system other than piping, tubing, flanges, and fittings must be tagged or labeled in accordance with the P&ID or system schematic and ESM Chapter 1, Section 200, "Numbering and Labeling."
2. Physical labeling must match the system schematic, and vice versa.

**M. Liquid lock**

1. Provisions must be made in the design either to withstand or to relieve the pressure increase caused by heating of static fluid in a piping component from environmental temperature changes.
2. For cryogenic systems utilizing ball valves, the ball must have an upstream relief hole to prevent over pressurization inside the ball cavity due to thermal expansion.
3. When relief protection is used, the piping system must be in accordance with ASME B31.3 Paragraph 301.4.2 (fluid expansion effects).
  - a. Liquid lock relief valves must be installed whenever cryogenic liquids can be trapped between closures.
  - b. For all liquids, relief valves must be installed between closures to prevent over pressurization of the pressure system, except when an analysis indicates the pressure of the trapped liquid will not exceed the MAWP of the components that contain the trapped liquid. A copy of this engineering analysis must be contained in the pressure system documentation.

- c. Liquid lock relief valves must not have a set point greater than 120% of the MAWP.<sup>32</sup>
- d. Liquid lock relief valves must be ½” NPS (nominal pipe size) minimum unless code-acceptable documentation in accordance with ASME B31.3 Paragr 300(c)(3) is available to demonstrate a smaller size is acceptable<sup>33</sup> (a 1/16” O.D. tubing length might be able to utilize a smaller relief valve than ½”).

CAUTION: The above reference to ½ in. NPS is not be intended to encourage the use of threaded pipe which is NOT recommended for most systems requiring leak tightness, especially hazardous fluid systems.

## N. Material Compatibility

### 1. General

- a. It is the designer’s responsibility to select materials suitable for the fluid service. Materials are to be selected that resist deterioration in service and give a good service life.
- b. When selecting materials such as adhesives, cements, solvents, solders, brazing materials, packing, and o-rings for making or sealing joints, the designer shall consider their suitability for the intended service.
- c. The nonmetallic components shall be made of materials which are compatible with the fluid service in the piping system and shall be capable of withstanding the pressures and temperatures to which they will be subjected in service.
- d. Materials are to be selected that will not contaminate the fluid service.
- e. ASME B31.3 F323 shall be followed.

### 2. Corrosion

- a. Corrosion rates must be established for materials used for the fluid service at the temperature and pressure they will be subjected to during service.
- b. *For systems with active corrosion (e.g. carbon steel and water), corrosion inhibitors should be utilized to reduce the corrosion rate.*
- c. Corrosion rates must be evaluated prior to selecting materials for fluid service at temperature and pressure. The manufacturer’s compatibility information may be used or a general guide like the National Association of Corrosion Engineers “Corrosion Data Survey” ISBN 0-915567-07-5.
- d. Passive Corrosion
  - i. *Systems that with passive corrosion (aluminum oxide, fluorine systems) should not be disturbed. Care should be taken to re-establish the passive corrosion layer.*

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<sup>32</sup> ASME B31.3 Chapter II, Part 6, paragraph 322.6.3

<sup>33</sup> ASME Section VIII Division 1, Part UG-128, and B31.3 paragraph 322.6.3.

- ii. Fluorine systems shall be passivated (see Ultrapure Gas Delivery “Preparing a gas delivery system for excimer lasers with fluorine passivation of 316L stainless steel” by Eugene, J. Karwacki Jr., Kerry R. Berger, Ronald M. Pearlstein, and Robert J. Haney Air Products and Chemicals)
- e. Corrosion effects shall be considered by the designer for the fluid service and the temperature and pressure of the fluid service
  - i. The susceptibility of the piping material to crevice corrosion under backing rings, in threaded joints, in socket welded joints, and in other stagnant, confined areas
  - ii. The possibility of adverse electrolytic effects if the metal is subject to contact with a dissimilar metal
  - iii. The effect of stress corrosion.
  - iv. The effect of intergranular corrosion (austenitic stainless steel carbide precipitation and chromium depletion)
  - v. The effect of hydrogen embrittlement.
  - vi. The effect of pitting corrosion.
  - vii. The effect of Microbiologically Influenced Corrosion.
  - viii. The possible corrosion under insulation effect.
  - ix. The effect of erosion corrosion.
  - x. The effect of environmental cracking.
  - xi. The effect of electrolytic corrosion
  - xii. The effect of selective corrosion attack on structural constituents.
  - xiii. The effect of exfoliation corrosion.
  - xiv. The effect of interfacial corrosion.
- 3. Gaskets
  - a. Gaskets shall be selected so that the required seating load is compatible with the flange rating and facing, the strength of the flange, and its bolting.
  - b. Gaskets shall be made of material which is compatible with the fluid service and shall be capable of withstanding the pressures and temperatures to which they will be subjected in service.
- 4. Lubricants or Thread Compound.
  - a. Any compound or lubricant used in threaded joints shall be suitable for the service conditions, and shall be compatible with the piping material and the service fluid.
- 5. Cleaning
  - a. *The purpose of cleaning is to remove harmful deposits from all parts of the fluid system that come into contact with the fluid service during operation. All*

*foreign materials, fatty acids, oils and grease, loose mill scale, rust, paint, and similar materials should be removed. Any solution employed should be a good cleaning agent for these purposes and should be compatible with the materials of construction.*

- b. Chemical cleaning is conducted with solvent solution primarily for the purpose of removing mill scale and products of corrosion. The solvent solution may be acidic or basic, or successive solutions of differing character may be employed. Because of the chemical control required to ensure a successful cleaning, to avoid damage to both ferrous and nonferrous materials through improper use of the solvent, and because of the potential dangers involved in dealing with corrosive solutions and possibly explosive and toxic products of the cleaning process, affect of the cleaning agent on the substrate must be evaluated.
  - c. Cleaning agents must be evaluated to verify compatibility with the fluid service.
  - d. Cleaning agents must also be evaluated to verify removal based on the engineering design.
  - e. For oxidizer fluid service, special cleaning and inspection is required to 175A or better as defined in ASTM G93 para. 11.4.3.
  - f. For fluorine service, establish initial cleanliness levels of 175A or better as defined in ASTM G93 para. 11.4.3.
6. Low Temperature
- a. At operating temperatures below  $-191^{\circ}\text{C}$  ( $-312^{\circ}\text{F}$ ) in ambient air, condensation and oxygen enrichment occur. These shall be considered in selecting materials, including insulation, and adequate shielding and/or disposal shall be provided.
7. Flexible Elastomeric Sealed Joints
- a. Assembly of flexible elastomeric sealed joints shall be in accordance with the manufacturer's recommendations.
  - b. Any solvents or lubricant used to facilitate joint assembly shall be compatible with the joint components and the intended service.
  - c. Flammable vapors shall be purged prior to hot work.
8. Hydrogen, Deuterium, and Tritium Service
- a. Systems in Hydrogen, Deuterium, and Tritium service shall follow ASME B31.12.
  - b. Tritium systems shall meet DOE-HDBK-1129, Tritium Handling and Storage.
9. Welding, Brazing, and Soldering Materials
- a. When required, fluxes shall either be compatible with the fluid service or removed.

- b. Dissimilar material connections involving welding or brazing of piping components or attachments to those piping components shall be as required by the engineering design.
10. Plastic Piping
- a. Adhesives, cements, and sealers used to join piping components shall be compatible with the materials being joined and shall conform to applicable ASTM specifications.
  - b. Joining materials that have deteriorated by exposure to air, that are beyond the shelf life recommended by the manufacturer, or that will not spread smoothly shall not be used.
11. Organic material selection
- a. Manufacturer's compatibility information must be reviewed prior to selection of material for fluid service at the system temperature and pressure.
  - b. *For general use, the Parker Hannifin Corporation O-Ring Division "[Parker O-Ring Handbook](#)" ORD 5700 may be used to evaluate the materials.*
12. Acetylene
- a. *In all cases, copper, silver, and mercury should be excluded from contact with acetylene in transmission and control systems. Copper content of 65% may be used if the designer specifies the specific item.*
  - b. *The common nonmetallic materials that have been found satisfactory for use with acetylene include asbestos, polytetrafluoroethylene (PTFE), polychlorotrifluoroethylene (PCTFE), polyamide (PA), natural and synthetic rubbers, and leather. Gaskets are not to contain copper, silver, or mercury.*
  - c. *Cast iron and semi-steel which may be exposed to the pressure effects of an acetylene deflagration or detonation is not recommended.*
  - d. *Aluminum should be avoided, since it may become corroded by exposure to calcium hydroxide formed in the production of acetylene from calcium carbide.*
  - e. *For additional information reference CGA G1.2-2006 Acetylene Metering and Piping.*

## O. Oxygen Systems

1. Design of systems used for oxygen/oxidizer service must conform to ASTM G 128 and NFPA 55.
2. Selection of components and soft-good materials (e.g., valve gaskets), must be evaluated for oxygen/oxidizer material compatibility.

3. To mitigate adiabatic compression heating, fast acting valves (e.g., ball valves, solenoid valves) must not be used as pressurization valves or vent valves.<sup>34</sup>
4. Must be designed to mitigate human error (i.e., should not rely on operator to open valves in a specific sequence or timeframe). Selection and placement of components must take priority over operator compliance with procedures.
5. Must be designed to allow for periodic maintenance (e.g., replace components and soft-goods that have oxidized) and must provide a means for maintaining cleanliness level during maintenance.
6. Design must incorporate means to prevent adiabatic compression that could lead to ignition.
7. If system design cannot be controlled through component selection, operating practices, compatible materials, or when the system cannot be modified to improve its compatibility then shielding, must be placed around the system.
8. Ensure adequate fire suppression devices/systems are strategically located near or around all oxygen/oxidizer systems (see NFPA 45 for guidance in laboratory areas).

**P. Restraints for Flexible Hoses, Tubing, and Relief Device Discharge Tubing.**

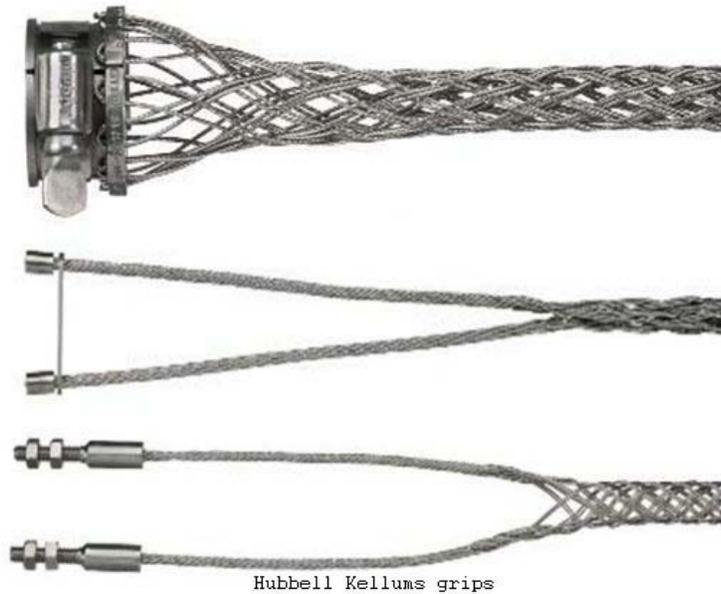
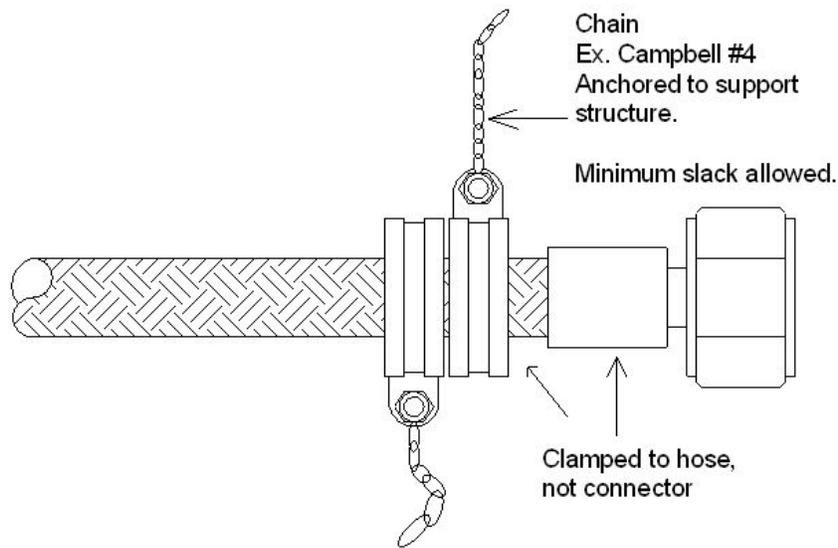
1. Relief device discharge lines, flexible tubing, and vent lines must be evaluated for reaction thrust considerations, and must be sufficiently braced to withstand the maximum and sustained thrust potential.<sup>35</sup>
2. Approved alternatives (of those shown below) or restraining devices approved by a designer may be used if the restraining device withstands the thrust challenge posed by both the initial surge thrust and the sustained surge thrust.
3. Flexible tubing and hoses over 12 inches in length and in service pressure greater than 150 psig must be constrained at both ends or shielded in case of end-connector failure. The maximum separation distance between flexible hose restraints must not exceed 6-ft intervals. (e.g., an 8-ft. flexhose must use 3 restraints).
4. Safety grips (e.g., Kellums® grips or Adel® clamps #MS-21919DG shown below) connected from hose to hose, hose to structure, or from hose to other components must be used and must be capable of restraining the hose or end fittings in the event of joint separation unless an adequate alternative for personnel protection is provided. Example shown below:<sup>36</sup>

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<sup>34</sup> ASTM G 88

<sup>35</sup> ASME Section VIII, Division 1 Part UG-22, and Appendix M (M-12). ASME B31.3 Paras. 301.5.5, 319.5, and 322.6.2.

<sup>36</sup> Flexible element restraints concepts throughout this section: WSTF WSI-SW-0024.B (NASA White Sands Test Facility Standard Instruction), industry standard, and lessons learned.



5. Flexible tubing/hoses enclosed inside equipment or test setups that do not expose personnel to injury when pressurized are excluded from being secured.
6. Hoses which are located inside glove boxes and whipping poses no personnel danger are exempt from requirements for flexible element restraints.
7. Specifically excluded are free-rotating/translating systems whose designs prohibit securing at 6-ft intervals.

**Q. Piping and Tubing**

1. Piping or tubing must be protected with a pressure relieving device. In instances where a pressure relieving device cannot be installed, the piping must be designed to withstand the highest pressure that can be developed (see Code Case 2211, and ASME Section VIII, Division 1, part UG-140).
2. Wall thinning caused by bending of tubing must be accounted for when performing MAWP calculations, as defined in ASME B31.3 Chapter II, Paragraph 304.2.
3. Determination of piping/tubing MAWP, or wall thickness required for a specific internal design pressure, must be verified prior to selection by performing the following calculation as found in ASME B31.3, paragraph 304 for piping/tubing where  $t < D/6$ :

$$\text{To find wall thickness : } t = \frac{PD}{2(SEW + PY)}$$

$$\text{To find MAWP: } P = \frac{2SEWt}{D - 2tY}$$

Where:

t= pressure design wall thickness of tubing.

P= Internal design pressure

D= Outside diameter of pipe/tubing as measured

S= Stress value for material from ASME B31.3 Table A-1

E= quality factor from ASME B31.3 table A-1A or A-1B

W= Weld joint strength reduction factor per ASME B31.3 paragraph 302.3.5(e).

Y= Coefficient from ASME B31.3 Table 304.1.1

4. The following formula may be used for determination of piping schedule. Variables are the same as above.

$$\text{Schedule} = \frac{1000P}{s}$$

5. For piping/tubing used in pressure systems designated as “High Pressure Fluid Service” (as defined in B31.3 Chapter IX), wall thickness of piping and tubing must be determined using ASME B31.3 Chapter IX, Para K304.
6. Unlisted piping/tubing must meet the requirements of ASME B31.3 Chapter III.
7. Piping/tubing of unknown material specifications must not be used in pressure systems.
8. Non metallic piping and piping lined with nonmetals must conform to ASME B31.3 Chapter VII.
9. ASME B31.1 must be used for steam system piping where the steam, or vapor generated is greater than 15 psig, and high temperature water is generated at pressure exceeding 160 psig, and/or temperatures exceeding 250°F.
10. *Guidance:* Use of seam-welded pipe or tubing is strongly discouraged.

**R. Piping Components**

1. Refer to Section 5.0 of this Chapter for the definition of Piping Components, which clarifies which pressure system components are subject to the listing requirements of ASME B31.3.
2. Piping components that meet a listed standard in ASME B31.3 must be selected for use in construction or fabrication of a piping system. Piping components that conform to a published specification or standard may be used, provided that a documented review of the specification indicates the component meets the ASME code. Unlisted piping components must be evaluated based upon criteria of ASME B31.1, ASME B31.3, or ASME Section VIII.
3. ASME B31.3 does not apply to instruments, except for inline portions of instruments. Non-inline instrumentation is not required to be evaluated against guidance for piping components. Refer to Sub-section S of this Chapter for requirements associated with instruments.
4. Pressure systems must have all major components (flexhoses, valves, pumps, vessels, gages, pressure transducers, flow meters, etc) documented on the attached components list form and must be maintained in the pressure system documentation package. The following must be provided as a minimum for all components:
  - a. Manufacturer
  - b. Model Number
  - c. MAWP
  - d. Material (e.g., 316 stainless, brass, etc.)

**S. Piping Flanged Joint Connection Assembly**

1. Must conform with one of the following:
  - a. Manufacturer recommendations based on the joint design and all materials of construction
  - b. ASME PCC-1, "Guideline for Pressure Boundary Bolted Flange Joint Assembly"
  - c. ASME Section VIII Appendix 2, Rules for Bolted Flange Connections with Ring Type Gaskets
  - d. Special calculations by the designer with concurrence by CPSO
  - e. Applicable B31 piping code

**T. Piping Supports and Flexibility Analysis**

1. Follow B31.3 Process Piping for piping supports. Guidance: LANL B31.3 Process Piping Guide D20-B31.3-G is also available.
2. Flexibility analysis of a piping system must be performed on all systems. The analysis must conform to the requirements as defined in ASME B31.3, Chapter II paragraph

319.4.2. Exceptions to this requirement are the following, as defined by B31.3 paragraph 319.4.1:

- a. Those that are duplicates of successfully operating installations
  - b. Those that can be judged adequate by comparison with previously analyzed systems.
  - c. Systems of uniform size that have no more than two anchor points, no intermediate restraints, and fall within the limitation of the equation found in ASME B31.3 Paragraph 319.4.1.
3. Tubing that is anchored to beams of dissimilar material properties, in temperature varying environments (i.e. stainless steel tubing braced to a carbon steel I-beam on the exterior of a building) must incorporate flexibility, which is induced by thermal expansion/contraction.
  4. Additional requirements for anchoring are in ESM Chapter 5 Structural (e.g., ASCE 7) and Master [Specifications](#) 22 0529 *Hangers and Supports for Plumbing, Piping, and Equipment* and 22 0548 *Vibration and Seismic Controls for Plumbing, Piping, and Equipment*.

#### U. Pressure Relief Requirements

1. Pressure vessels and piping must have protection against over-pressurization.
2. Maximum inlet piping pressure drop must be in accordance with ASME Section VIII, Div 1, part M-6, and Div II, Section 9.
3. The nominal pipe size of piping, valves and fittings, and vessel components between a pressure vessel and its safety, safety relief, or pilot operated pressure relief valve must be at least as large as the nominal size of the device inlet.
4. For the above, the cumulative total of all non-recoverable inlet pressure losses must not exceed 3% of the valve set pressure, as based on the valve nameplate capacity, corrected for the fluid characteristics.
5. Discharge lines from pressure relief devices must be in accordance with ASME Section VIII, Div 1 Parts M-7 through M-12, and Div II Parts 9.A.4 through 9.A.5.
  - a. The design characteristics of the discharge system must be designed as such to accommodate the requirements of ASME Section VIII Div 1 Part UG-125.<sup>37</sup>
  - b. If unable to vent to a captured vent vessel, relief devices that vent flammable and/or toxic fluids must vent to the building exterior and away from ignition sources as defined in NFPA 30 and 45.
  - c. Discharge lines must be run as direct as practicable.
  - d. Water Boilers: Pipe discharge from safety relief valve, full size, to floor drain with a union or flange between the valve and discharge piping. Do not allow weight of piping to bear on relief valve.<sup>38</sup>

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<sup>37</sup> See ASME B&PVC Section I and IV for boiler-specific capacities.

- e. Steam Boilers: Pipe relief from safety valve to atmosphere above roof. Refer to Mechanical Drawing(s) ST-D3020-4, Steam Drip Pan Elbow, for additional requirements.<sup>39</sup>
6. Pressure relief devices must have calculations as defined by [AP-341-605](#). A copy of the calculations must be maintained in the pressure system documentation package. Calculations must define required flow capacity to prevent system pressure from exceeding 110% (or 116%, 120%, or 121% when allowed by ASME Section VIII, Division 1 part UG-125) of the MAWP of the component it is protecting during maximum fault conditions (see Exclusions section).
7. A full verification record is not required for relief devices installed, and designed by the original manufacturer of a pressure system. However, if the manufacturer or system owner cannot supply documentation justifying the design of the pressure relief system, then calculations must be generated to ensure safe design.
8. Pressure relief devices for vessels that are to operate completely filled with liquid must be designed for liquid service, unless the vessel is otherwise protected against overpressure.
9. Pressure relief devices need not be installed directly on vessels, or components they are protecting, provided the following is met:
  - a. There are no flow control, or shut off valves between the component being protected and the relief device,
  - b. The relief device is suitable for the fluid service, meeting the capacity requirements for the application, and
  - c. Design ensures that the pressure of the vessel or component the valve is protecting does not exceed the MAWP at operating conditions, except as permitted in Section VIII Div 1.
10. In cases where the required use of pressure relief devices is not practical, pressure control methods may be used only by approval from the CPSO.
11. Pressure relief designs must include a calculation report that includes at least, but not limited to the following (for rupture disks adjust as appropriate):
  - d. Manufacturer
  - e. Model number
  - f. Inlet size and type
  - g. Outlet size and type
  - h. Set/burst pressure (psig)
  - i. Service fluid

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<sup>38</sup> 1997 IAPMO UMC, Section 1008. The referenced mechanical drawing provides piping detail for steam safety valves and additional design criteria.

<sup>39</sup> Ibid.

- j. Relieving capacity
  - k. Relieving capacity at overpressure percent<sup>40</sup>
  - l. Orifice trim (Not applicable to rupture disks)
  - m. ASME Code Section
  - n. Blow down (if critical, not required for rupture disks)
  - o. Determination of pressure relief device sizing
  - p. Determination of required relieving flow
  - q. Determination of inlet/outlet pressure drop at relieving conditions.
12. Pressure relief devices installed into a pressure system that protect ASME BPVC Section I, IV, VIII, or X equipment must be an ASME UV or UD stamped relief device as defined in Section VIII, Division 1 Part UG-125(a).<sup>41</sup>
  13. A pressure relief device's set point must not exceed the MAWP of the system, except where allowed by the applicable ASME code (e.g., liquid lock and fire sizing).
  14. A pressure relief device must have sufficient flow capacity such that system pressure does not exceed 110% of the system MAWP (or 116% as defined by ASME Section VIII Div 1 Part UG-125 for multiple relief devices), at full open source pressure.
  15. Relief device fire sizing calculations are required for relief devices that are used when a vessel and/or piping meet the definition as found in ASME Section VIII, Division 1 Part UG-125(c)(3), which states: "Pressure relief devices intended primarily for protection against exposure of a pressure vessel to fire or other unexpected sources of external heat installed on vessels having no permanent supply connection and used for storage at ambient temperature of non-refrigerated liquefied compressed gases."<sup>42</sup>
  16. Flow capacity of pressure relief devices that are intended primarily for protection against exposure of a pressure vessel to fire or other unexpected sources of external heat, that are installed on vessels having no permanent supply pressure connection (or can be isolated from pressure relief) and used for storage at ambient temperatures of non-refrigerated liquefied compressed gases, must not exceed 120% of the stamped set pressure of the valve, or the MAWP.<sup>43</sup>

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<sup>40</sup> Allowable percentage as defined by ASME Section VIII, Division 1 Parts UG-125 through UG-136, or ASME Section I and IV.

<sup>41</sup> Not a requirement for devices only protecting B31 piping systems.

<sup>42</sup> Pressure System Designer must determine need for fire sizing calculations. This Chapter does not impose specific requirements with regard to the manner in which the Pressure System Designer documents the determination of the need to evaluate a fire scenario in sizing pressure relief devices.

<sup>43</sup> ASME Section VIII, Division 1 Part UG-125 (c)(3)(a). See API 521 for calculations.

17. Boiler Pressure Relief
  - a. For hot water heating boilers, the pressure differential between the safety relief valve set pressure and the boiler operating pressure must be at least 10 psi, or 25 percent of the boiler operating pressure, whichever is greater.<sup>44</sup>
  - b. For low pressure steam heating boilers, the pressure differential between the safety valve set pressure and boiler operating pressure must be at least 5 psi, and the boiler operating pressure should not exceed 10 psi.<sup>45</sup>
  - c. For high pressure steam boilers (power boilers), relief systems must be designed using the calculations found in B31.1 Appendix II. Also, refer to ANSI/NB-23, Appendix F, for pressure differential between the safety valve set pressure and the boiler operating pressure.
18. Pressure Relief Valve Flow Tests: Where this is the only accurate method for determining relief system capacity, flow tests of relief systems must be performed as defined in ASME PTC-25 and API 521<sup>46</sup>. The objective of the test is to ensure that system pressure will not exceed over pressure percentage as defined in ASME Section VIII, Division 1 Part UG-125<sup>47</sup> (typically 110% above the MAWP), when allowed/approved by CPSO.<sup>48</sup>
  - a. For systems with multiple PRVs, liquid lock PRVs, and fire scenario PRVs, refer to ASME Section VIII Div 1, Parts UG-125 through UG-136 for further guidance:
    - 1) Relief devices must be tested in-place, installed in their designated systems, without modification to plumbing arrangement.
    - 2) The pressure measurement device that measures the pressure downstream of the flow-limiting device must be calibrated.
    - 3) Must be tested with the maximum supply (source pressure) pressure at full open flow (i.e. pressure regulator increased to maximum) while observing pressure readings.

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<sup>44</sup> NB-23, National Board Inspection Code, Appendix F.

<sup>45</sup> Ibid.

<sup>46</sup> In-house certification of relief system to verify flow capacity of system, not for UV stamping of relief valves (LANL does not manufacture relief valves or hold a UV stamp). PSO considered authorized observer under LANL jurisdiction.

<sup>47</sup> See also ASME B&PVC Section I and IV for boiler specific applications

<sup>48</sup> ASME Section VIII Div 1, UG-131 requires flow checks to validate capacity of relief valves. Method used to validate relief system flow characteristics and performance to ensure UG-125 percentages are maintained/ achieved when piping and fittings are installed on relief valve ports. Testing must comply with NBIC/NB-23 Part 2, section 2.5.7, and ASME PTC-25 Part II, Section 4, part 4.3 "In-service Testing Procedures". Capacity compliance must be based on ASME Section VIII, Division 1 Part UG-125

- 4) If it appears, as the pressure is gradually increased as the relief valve is flowing, that the pressure in the system will exceed 110% of the MAWP of the system, the test must be stopped immediately. The valve is undersized, or the pressure relief tubing is causing too much flow restriction. The relief system design has failed the test and needs to be redesigned.
    - a) System must not be allowed to operate until provisions have been made to accommodate for required relief capacity as defined by ASME Section VIII, Division 1 Part UG-125.
  - 5) If the relief valve maintains the system pressure below 110% of the MAWP, (at maximum flow of the pressure regulator) of the system, then the relief system is designed and sized appropriately.
    - b. Relief device flow tests must be documented and witnessed by PSO.
    - c. The following information must be obtained after the flow check with the pressure system documentation:
      - 1) The source supply pressure
      - 2) Manufacturers model number and serial number of the relief device
      - 3) Set pressure of the relief device
      - 4) Gauge calibration tracking number and due date.
      - 5) Maximum pressure obtained during the flow check
      - 6) Indication of design/sizing failure to maintain pressure below 110% MAWP (or as specified by ASME Section VIII, Division 1, part UG-125)
      - 7) Pressure measurement device calibration tracking number, and due date
      - 8) Any special provisions must be stated in the flow test documentation (i.e. installation of an upstream orifice at the pressure source to minimize flow rate.)
19. The use of stop valves is not allowed for heating boiler applications, and is discouraged for other applications, but may be used when all the following requirements are met:<sup>49</sup>
- a. The increase in pressure drop from the stop valve does not reduce the relieving capacity of the vent system below what is required.
  - b. The stop valve must be locked in the open position during system operation. For a stop valve to be satisfactorily locked in the open position it must have a physical means to inhibit unplanned operation of the valve. The lock must be key-operated.
  - c. Closing of the stop valve requires the system to be safe with strict procedural controls in place to warn personnel of the possible hazards.
  - d. If the above cannot be met, but a stop valve is required for operations, documented approval/variance must be obtained through the CPSO.

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<sup>49</sup> See ASME Section VIII Div 1 Part UG-135(d), and B31.3 paragraph 322.6.1

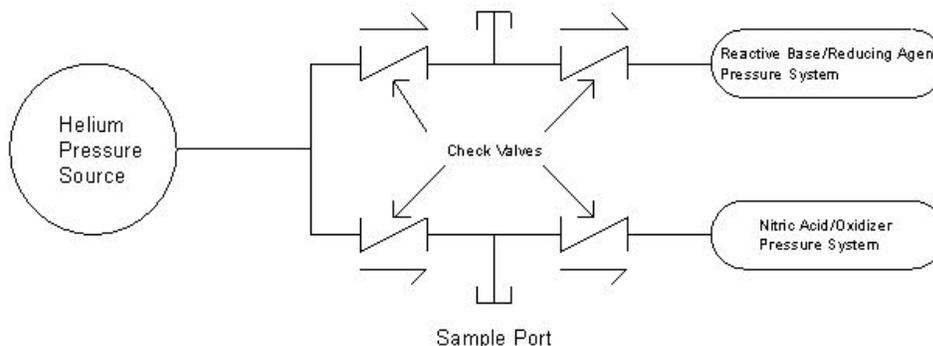
**V. Pressure Vessel Requirements**

1. Pressure vessels must either have calculations as defined by AP-341-605 or manufacturers data report (i.e., U-1 or U-1A report).
2. Pressure vessels, in a pressure system, that fall under the scope of ASME Section VIII, must be ASME stamped, NBIC registered, and copies of the manufacturer's data reports (U-1A forms), must be provided as part of the procurement package. A copy of these documents must be maintained in the pressure system documentation package.
3. Pressure vessels with a design pressure less than 10,000 psig must be designed, and fabricated according to ASME BPVC Section VIII, Divisions 1 and 2, where Division 2 focuses on design by analysis.
4. Pressure vessels with a design pressure exceeding 10,000 psig must be designed, and fabricated in accordance with ASME BPVC Section VIII, Division 3.
5. Vessels that, by design limitations, cannot be ASME-code-stamped must be proven equivalent as code stamped using the most applicable ASME B&PV code(s) for design, inspection, and testing. All requirements of the applicable code(s) must be documented and maintained in the pressure system documentation package, and must be approved by the CPSO.
6. Vessels, other than ASME-stamped vessels or DOT vessels, used within their intended service must have documentation justifying their use. Requirements in ASME Section VIII or other applicable code for this specific type of construction must be followed and verified. Documentation must include, but is not limited to:
  - a. Material
  - b. Material condition
  - c. Thickness of major pieces
  - d. Corrosion allowance
  - e. Weld qualification
  - f. Calculations, to include flanges, manholes, nozzles, etc
  - g. Loading listed in ASME Section VIII, Div 1 Part UG-22
7. DOT or mobile pressure systems must be retested per 49 CFR or ASME Section XII.
  - a. Refilling of an expired DOT portable vessel is prohibited
  - b. Expired DOT vessels which still contain the contents may be used until the contents are gone, provided that no pressure source is connected to the vessel. Removal of contents must be by gravity or vapor pressure only.
  - c. If the vessel is to be used as a permanent installation and not maintained in accordance with 49CFR, the vessel must be reviewed according to ASME Section VIII, and the DOT stamp must be obliterated.
8. Vendor Assembled or Manufactured Pressure Systems (those types of components or systems that are considered to be non-excluded as defined by this document).
  - a. Procurement specifications for new pressure systems or vessels, or modifications to existing pressure systems must be submitted to the CPSO for review and evaluation before the procurement action or the modification.
  - b. Manufacturer's supplied data must be stored in the pressure system documentation package.

- c. The designer must review and define the contents of the pressure system documentation package specifically for the vendor supplied pressure system/vessel.
  - d. When a component of a vendor-supplied pressure system is serviced or changed from the original delivered configuration that item must be processed per this chapter.
9. Fiber-Reinforced Pressure Vessels (ASME Section X)
- a. Fiber-reinforced plastic pressure vessels in a pressure system must be ASME-stamped (RP stamp) and NBIC-registered, and copies of the manufacturer's data reports (e.g., RP-1, RP-2, Q106, Q107, etc.) must be maintained in the system documentation package.

**W. System Interactions**

1. Where two or more dissimilar pressure systems tie into each other and/or are fed by a single pressure supply, they must be reviewed to determine the need for installation of check valves. *The following scenarios should be considered:*
  - a. *Use of double block and bleed may fail due to human error*
  - b. *Where two dissimilar systems must be continuously pressurized from a single pressure source.*
  - c. *Systems can be potentially over pressurized by the other.*
  - d. *System contents may back flow into the other and cause contamination or over pressurization.*
  - e. *System contents migration into the source pressure supply, which can potentially contaminate all other systems that connect to the same source.*
2. Double check valves in series must be installed on pressure systems to mitigate system fluid migrations and interactions where two or more incompatible fluid systems are pressurized by the same pressure source (e.g., monomethyl hydrazine and dinitrogen tetroxide systems pressurized by the same helium source). See example in figure below.



**X. Vacuum and Externally Pressurized Components and Piping**

1. Vacuum Vessels
  - a. Vessels that are subject to external pressure must be designed in accordance with ASME Section VIII. For example: See ASME Section VIII Division 1 parts UG-28 and UG-29.
  - b. Vacuum vessels and vacuum systems that have a source pressure or purge gas that exceeds 15 psig must be designed, fabricated, and tested according to ASME Code Section VIII, and B31.3.
2. Vessels, Piping and Tubing
  - a. Externally pressurized piping or vessels must be designed in accordance with ASME B31.3 Chapter II, Para 304.1.3 which references ASME Section VIII, 1 Div 1 parts UG-28 thru UG-30 (vessels under external pressure).<sup>50</sup>

**Y. Vent Systems**

1. All pressure systems must be designed with a means to manually vent pressure from the system.
2. Breaking loose fittings to vent pressure is absolutely prohibited. Vent systems must be supplied with means of controlled venting through a valve.
3. Except for captured vent systems (for lethal or toxic systems), vents must not be plugged.<sup>51</sup>
4. Vent ports should be covered with metallic screens or other type of device to inhibit exhaust ports being blocked by environmental phenomenon (e.g., insect nests). Screens/covers must not inhibit the flow capacity of the vent valve.
5. Relief devices that are in an environment which could cause the exhaust ports to be plugged (e.g., insect nests) must be fitted with a metallic screen or other device to keep them from becoming plugged. Screens/covers must not inhibit the flow capacity of the relief device.

**Z. Unlisted, Specialty, or Unique Components<sup>52</sup>**

1. Unlisted components allowed for new construction must demonstrate equal or greater level of safety at the pressure and temperature of the system. ASME B31.3 requires a safety factor of 3:1, ASME B31.1 requires a safety factor of 4:1. For existing systems, refer to Section 10.0.
  - a. Variance VAR-2010-001.0 evaluated Swagelok (including the old brands of Whitey, Cajon, and Nupro) to meet the ASME B31.3 304.7.2 requirements, and Swagelok components (tubing, fittings, and valves only) are allowed for use in construction of new code compliant systems at LANL.

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<sup>50</sup> ASME B31.3 has specific requirements for variables, "L" and "S" as defined in Section VIII, Div 1.

<sup>51</sup> In case venting is required in an emergency

<sup>52</sup> See ASME B31.3, para 302.2.3. Listed components can be found in Table 326.1.

2. The master list of Unlisted Components allowed for use is maintained on the ES-DO Pressure Protection Program web site.
3. Components that are not built to the standards listed in the codes -- including those built to other standards, manufacturers' standards, or built by LANL -- must be qualified by the owner and/or the designer as follows:
  - a. Components built to other published standards, or standards that are not listed in the ASME Code may be used with the following limitations:
    - (1) The pressure design must meet applicable ASME Code requirements
    - (2) The designer must be satisfied of comparable code construction.
  - b. Components built to manufacturers standards:<sup>53</sup>
    - (1) The system owner must obtain and provide documentation (to be maintained in the pressure system documentation package) which support how the materials, design, and fabrication of the component meet the applicable ASME Code requirements.
  - c. Components built at LANL
    - (2) Requires qualification by engineering calculations to support pressure design consistent with the applicable code.
    - (3) Calculations must be substantiated by one of the following methods:
      - i) Extensive successful service under the same loading and service conditions
      - ii) Experimental stress analysis<sup>54</sup>
      - iii) Proof test (e.g., Sect VIII UG-101 would be 3X design pressure)
      - iv) Detailed stress analysis (such as finite element method)<sup>55</sup>
4. Documentation of acceptability must be by calculation. A form is also available to assist in evaluating unlisted components.

#### AA. Welding Design

1. Design must address the following criteria (e.g., weld design calculations, drawings) as defined by the applicable code of construction and ESM Chapter 13, Welding, Joining, & NDE:
  - a. Weld procedure specifications (WPS)
  - b. List of welding materials, to include filler materials
  - c. Heat treatment requirements

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<sup>53</sup> "Proof" discussed in ASME B31.3 paragraph 304.7.2.

<sup>54</sup> See ASME Section VIII, Division 2, Annex 5.F.

<sup>55</sup> See evaluation as described in ASME Section VIII, Division 2, Part 5.

- d. Method of welding, brazing or soldering (e.g., GTAW, SMAW, oxyacetylene, etc.)
- e. Cleaning methods
- f. Contain engineering design calculations or other approved ASME method that establishes the structural integrity of the design.
- g. Specify the method(s) to examine the weld as defined by the appropriate ASME code (e.g., Section VIII Div 1 or B31.3)
- h. Specify the pass/fail criteria to apply to the method(s) used to examine the weld.
- i. Detail joint geometry, weld type, size, material type, and specification.
- j. Utilize welding symbols in accordance with AWS A2.4 “Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- k. See also ESM Chapter 13 Welding Fabrication Procedure WFP 2-01, ASME B31 Series Piping Codes.

## 12.0 Procurement, Fabrication, and Assembly

### A. General

1. LANL Master Specification 43 4113 “Gas and Liquid Pressure Vessels” must be used for design/build procurements of pressure vessels. This specification is applicable both to new acquisitions and to modification or repair work to existing pressure vessels.
2. Vessels must be code-fabricated and code-stamped; however, if required design features prevent code compliance, then follow the Non-Code Vessels section of this document.
3. Including all other references to procurement requirements in this document, all procured pressure systems and components must cite the following where applicable, and must be received with documentation from the manufacturer or vendor showing proof of compliance. Documentation must be maintained in the pressure system documentation package.
  - a. Applicable ASME Code Inspection and testing documentation
  - b. Cleanliness level oxygen/oxidizer components must be 175A or cleaner as specified in this document and ASTM G93
  - c. Welding specification, including inspection, and testing, where applicable.
  - d. Operating conditions
  - e. Loadings (snow, wind, seismic, etc) as found in ESM Chapter 5 must be included.

### B. Rupture Disk Procurement

1. Where reverse buckling rupture disks must be procured, procure only rupture disks that have a damage ratio  $\leq 1.0$ .

**C. Relief Valve Pre-Testing**

1. Prior to installation, new pressure relief valves must be independently tested to ensure the set point is correct as specified when ordered (beginning September 2010). Such testing is not required if:<sup>56</sup>
  - a. PRV setpoint adjustment is sealed by supplier and seal is unbroken, or tamper proof and supplier meets the code of construction requirements.
  - b. For ML-1 or ML-2, the supplier is on the LANL qualified suppliers list (IESL, internal: <http://int.lanl.gov/orgs/qa/pq/docs/iesl.pdf>) or approved by the CPSO. Guidance: CPSO approval listing (future) would be posted at ES-Division Pressure Safety homepage (internal): <http://int.lanl.gov/orgs/es/pp/index.shtml>
  - c. If testing is required, it must be performed in accordance with this document, and the applicable portions of ASME PTC-25, and then sealed.

**D. Rental Pressure Systems**

1. Rental pressure systems must be maintained in accordance with the applicable laws and national consensus codes and standards by the vendor owner.<sup>57</sup> Documentation must be made available upon request.
2. Rental pressure systems must be verified maintained by the owner.

**E. ASME Code-Stamped Vessels**

1. Procure from a manufacturer holding an ASME Code stamp as defined by the applicable ASME B&PVC Section, and have vessel stamped accordingly.
2. A copy of the manufacturer's data reports (e.g., U-1A, U-2, etc) must be supplied with the vessel, and must be maintained in the pressure system documentation package.
3. The ASME Code design calculations must be obtained as part of the procurement, but may be completed by others (e.g., LANS or an Architect/Engineer)
4. Receipt inspection of fabricated vessels must include verification of manufacturer's data reports (e.g., U-1 form), and visual identification of "U" stamp.

**F. Non-Code Vessels**

1. Procurements of non-code stamped vessels must be reviewed by CPSO.<sup>58</sup>
  - a. Vessel MAWP and over pressure protection is sufficient to achieve code equivalent protection from over pressurization.

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<sup>56</sup> Contact MSS division for relief device testing capabilities. API recommended practice; experience of need at NASA, SRS, Y-12; and commercial nuclear practice.

<sup>57</sup> Captured by LANL ASM [Form](#) 410 (3041.00.0410) Goods and Services Requiring Internal Review and Approval.

<sup>58</sup> Ibid.

- b. Design, and inspection documentation is readily available (weld inspection, pressure tests, etc).
  - c. Have calculations and documentation generated indicating the minimum wall thickness requirements to justify the MAWP.
2. For on-site fabrication, calculations (weld, MAWP, wall thickness, etc) must also be submitted to the CPSO prior to fabrication.

#### **G. Flexible Hoses and Flexible Tubing Procurement**

1. Flexible hoses must not be procured without end connectors attached by the manufacturer.
2. Flexible hoses must be procured from the manufacturer with the MAWP stamped, or etched, or tagged on the hose or end connectors indicating the maximum allowable working pressure of the assembly.
3. Flexible hoses must not be assembled or repaired, except by manufacturer.

#### **H. Tagging and Labeling**

1. Tag/label all piping and components as shown on the system schematic. Follow ESM Chapter 1, Section 200.

#### **I. Welding, Brazing, and Soldering**

1. Welding, brazing, or soldering on pressure systems, piping, and components, that are within the scope of this program must comply with the applicable ASME BPV or B31 codes. Proof of ASME compliance must be accomplished by documenting the following:
  - a. Welder qualifications as defined by the applicable code and ESM Chapter 13.
  - b. Welding procedure specifications (WPS) as defined by the applicable code and ESM Chapter 13.
  - c. Inspection, examination, and testing, (e.g. radiography, dye penetrant, or pressure qualification test) as defined by the applicable code of construction, to include other requirements defined in ESM Chapter 13.
2. Welding procedures and personnel must be certified for the application that they are performing through the LANL welding program, as defined by ESM Chapter 13. See also LANL Master Specification Sections 01 4444 and 01 4455 on welding.
3. Fabrication shops that do not possess an ASME "U" authorization, regardless of individual personal training, qualifications, and certifications, must not be considered equivalent to Code-certified shops and hence must only perform non-Code welding.
4. Welding on pressure systems or components must be inspected as mandated in the applicable ASME BPV or B31 codes by a certified inspector as defined in ESM Chapter 13.
5. Welding/brazing qualifications must conform to the ASME Section IX, "Welding and Brazing Qualifications," and the requirements of ESM Chapter 13.

6. On-site welding must be performed by welders that are currently certified, having completed testing and qualification in accordance with ESM Chapter 13, GWS 1-05, "Welder Performance Qualification/Certification."
7. When welded joints (e.g., orbital, butt welding) are used, all welds must have examination records as required by "Inspection, Examination, and Testing" Chapter VI of ASME B31.3 or ASME B31.1 as appropriate, and must be traceable by one of the two following methods:
  - a. A weld number referenced on the system drawing or sketch and pertinent information for each weld (weld map).
  - b. A stamp traceable to the welder along with examination records.
8. Welding inspection, examination, and testing records must be maintained in the pressure system documentation package.

#### **J. Piping and Tubing**

1. Bending of tubing/piping must be performed such that there is no wrinkling, stretching, or ovaling of the tubing. Use of tubing mandrels for thin walled tubing is mandatory.
2. Sand, beads, or other abrasive material must not be used to accomplish uniform bends for pressure system tubing/piping.
3. Tubing that is anchored to beams of dissimilar material properties in temperature varying environments (e.g., stainless steel tubing braced to a carbon steel I-beam on the exterior of a building) must have the flexibility needed for thermal expansion/contraction.
4. Use of tube cutting wheels is discouraged (but not prohibited) for stainless steel tubing.
5. Tubing must be prepped by interior and exterior reaming prior to fitting makeup. The end face of the tubing must be flat as possible and without sharp edges after reaming.
6. For such installations, follow LANL Master Spec [Sections](#) 40 0511 and 40 0527.

#### **K. Cleaning**

1. Components, piping and tubing specified for oxygen or oxidizer service must be cleaned as specified in this document, prior to assembly, and must be assembled in a manner that maintains cleanliness.
2. Pressure systems must be considered for cleanliness requirements. All components must be cleaned to an acceptable level which removes contaminants that could lead to system failure or contamination.

#### **L. Alignment<sup>59</sup>**

1. Twisting or distortion of piping or components, to bring into alignment, which introduces strain in the equipment, is strictly prohibited.
2. For flanges, faces and bolt holes must be aligned per B31.3, paragraph 335.

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<sup>59</sup> ASME B31.3 Para 335 Assembly and Erection, unless noted otherwise.

3. Prior to assembling any joints to be cold sprung, supports and anchors must be examined to ensure that required movement is allowed by the supports, and that undesired movement is controlled.

**M. Flanged joint assemblies:**<sup>60</sup>

1. Flanges must be replaced whenever any damage has been caused to the sealing surface that prevents the gasket from sealing. Excessive torque beyond torque specifications to achieve a leak free seal is strictly prohibited.
2. Torque up of flange bolts must be that which is defined by calculation or as determined by industry torque-table values, and must be defined in assembly instructions.
3. Bolted flanges must be re-torqued no less than 24 hours after initial torque following assembly, and prior to any leak checks or pressure verification tests.<sup>61</sup>
4. Nuts must have full thread engagement on the bolts or studs. One to two exposed threads is the preferable amount that defines full thread engagement. The minimum acceptable engagement is the outer edge of the nut being not less than flush with the end of the bolt or stud.<sup>62</sup>

**N. Threaded Joints**

1. Threaded fittings must be lubricated with lubricant that is compatible with the system fluid (e.g., halocarbon, hydrocarbon, fluorocarbon, etc.) prior to assembly to prevent galling and friction welding.

**O. Tubing Joints**

1. Flareless and compression tubing joints must be assembled per the manufacturer's instructions. Where the manufacturer specifies a specific number of turns for the nut, these must be counted from the point at which the nut becomes finger tight.
2. For Swagelok installations, follow LANL Master Spec [Sections](#) 40 0511 and 40 0527.
3. Flared tubing must be visually inspected for surface pits, and splits prior to assembly. Use of a "Go, No-Go" gauge for flare sizing is highly recommended.
4. Flared tubing with imperfections in the flare must be rejected.

**P. Oxygen and Oxidizing media components cleanliness requirements**<sup>63</sup>

1. General requirements
  - a. This section is applicable to both liquid oxygen (LOX) and gaseous oxygen (GOX) systems and other similar oxidizing agents (e.g. N<sub>2</sub>O<sub>4</sub>, HNO<sub>3</sub>, etc.)

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<sup>60</sup> Ibid.

<sup>61</sup> Accommodate material relaxation. Industry good practice.

<sup>62</sup> LANL ASME B31.3 Process Piping Guide ESM Chapter 17 Section D20-B31.3-G

<sup>63</sup> ASTM G 93

- b. Components installed into oxygen or oxidizer fluid systems must be cleaned to a level equal to or better than 175A as defined in ASTM G93 para. 11.4.3, where the nonvolatile residue remaining after cleaning is less than 1 mg/ft<sup>2</sup>, and the particulate count is less than the following where “X” is the size of the particles counted:

Number of Particles Allowed	Size Range (µm/100 mL)*
0	X > 175
1	100 < X < 175
5	50 ≤ X < 175
20	X < 50
5	Fibers
*100 mL refers to the amount of solvent fluid (e.g. de-ionized water, isopropyl alcohol, HFE 7100, etc) that is used to flow through, or around the components (or tubing and fittings) to collect the particulate and non-volatile residue (or total carbon) samples described in ASTM G93.	

- i. Oxygen/oxidizer pressure systems must be disassembled for cleaning. Each component must be cleaned prior to assembly. Non-volatile cleaning agents may remain in trapped spaces, which could react with oxygen. Cleaning solutions may degrade non metals in an assembly. Caustic and acid cleaning solutions may cause crevice corrosion in assemblies.
- ii. Any method of cleaning may be utilized provided that cleaning method meets, or exceeds the requirements as defined in ASTM G93 for level 175A.<sup>64</sup> Components may be cleaned by the manufacturer.
- iii. Components must be maintained clean during the assembly/construction process.
- iv. *Oxygen-compatible lubricants should be applied after component cleaning*
- v. Components cleaned for oxygen service must not be left in the open, unprotected. Care should be taken to avoid contamination of particulate and oil deposits on surfaces that will be in direct oxygen service.
- vi. Components cleaned for oxygen service must be handled with clean gloves or handling devices to maintain oil-free cleanliness of component.

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<sup>64</sup> Refer to ASTM A 380 which describes cleaning, descaling, and passivation of stainless steel parts, equipment and systems.

2. Cleaning procedures
  - a. The cleaning method used must incorporate three cleaning steps as defined in ASTM G93 as follows:
    - i. Precleaning – removal of gross contaminants
    - ii. Intermediate cleaning – use of alkaline salts, detergents, acids, or caustics to remove solvent residues and residual contaminants.
    - iii. Final cleaning- removal of minute contaminants, in a clean room environment. Includes drying/purging and packaging to protect components from re-contamination.
  - b. Cleanliness verification must be documented and maintained in the pressure system documentation package.
3. Packaging
  - a. All packaging used to for cleaned components must be as clean as, or cleaner than the clean level specified for the component. Packaging must be clearly marked in accordance with ASTM G93 para 12.2, “Package Marking.”
  - b. Cleaned components that are not bagged/wrapped must be plugged/capped with plugs/caps that are as clean or cleaner than 175A.
4. Assembly
  - a. Where applicable, all components cleaned for oxygen service must be handled with clean, lint free gloves to prevent contamination to the fluid surfaces of the component.
  - b. Components must be maintained clean to the maximum extent possible during the assembly process.
  - c. Care must be taken to minimize the potential for contamination
  - d. Only use of oxygen compatible grease is authorized for thread lubrication. A listing of tested materials is available in ASTM G63.
  - e. PTFE tape is authorized for NPT fittings cleaned for oxygen service. Ensure that the tape is applied so that it does not extend into the flow path<sup>65</sup>.
  - f. Ensure all tubing has been pre-fabricated, properly de-burred and cleaned prior to assembly.
  - g. Ensure all weld slag has been removed from interior of lines.
  - h. After assembly and before wetting the system with oxygen, purge the system using clean, dry gaseous nitrogen to remove assembly generated contaminants through the system or to a benign location.

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<sup>65</sup> ASTM G93

## 13.0 Inspection, Testing, and Maintenance

### A. Inspection/Examination

NOTE: It is the responsibility of the designer, the manufacturer, the fabricator, and the erector as applicable, to prepare the records as required for inspections and testing, that are defined by the most applicable ASME code.<sup>66</sup>

1. Pressure systems must be examined as defined by the applicable ASME code prior to service.
2. Examination activities to verify the quality of the work must be performed by persons other than those who performed the activity being examined. Such persons must not report directly to the immediate supervisors responsible for the work being examined.
3. The designer of a pressure system or component must define the examination requirements to meet or exceed those required by the applicable ASME code. Examination documents must be maintained in the pressure system documentation package. Examination methods must be specified in the engineering design, and must define type, extent and acceptance requirements for the following methods, as instructed by the ASME Code:
  - a. Visual inspection
  - b. Magnetic particle examination
  - c. Liquid penetrant examination
  - d. Radiographic examination
  - e. Ultrasonic examination
  - f. In-process weld examination
4. The designer must identify the minimum requirements of examination as defined by the code.
5. The manufacturer, fabricator or builder must perform examinations as required by the design documents and applicable code.
6. The fabrication, repair, or alteration documentation must have evidence of the examination; evidence must be maintained in the pressure system documentation package.
7. Where in-process weld examinations are substituted for RT or UT as allowed by ASME B31.3 Paragraph 341.4.3(3)(c), the in-process examination must be documented with the appropriate information as required by ASME B31.3, Paragraph 344.5 and this documentation must be maintained with the pressure system documentation package.

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<sup>66</sup> Example: ASME B31.3 Paragraph 346.

**B. Testing**

NOTE: The following testing criteria references B31.3 requirements; However, use the most applicable B31 code requirements in the event of conflict.<sup>67</sup>

1. Pressure systems must be pressure tested prior to service as defined in the applicable ASME code.
2. Facility pressure systems must be tested as defined in LANL Master Specification 22 0813.
3. Programmatic piping systems must undergo an initial leak check, and initial pressure qualification test as defined in B31.3 Chapter VI, Paragraph 345 (Testing) prior to being placed in service (or as defined in B31.1 Chapter VI). Test may be either pneumatic or hydrostatic, and must conform to the following:
  - a. A written procedure must be generated to instruct the test. Tests must be recorded and maintained in the pressure system documentation package.
  - b. The pressure of the leak test must be gradually increased in no less than three graduations, checking for leaks between each graduation.
  - c. All joints, including welds and bonds, are to be left un-insulated, and exposed for examination during leak testing (pressure qualification test).
  - d. Pneumatic pressure qualification tests must be conducted from a remote location with positive control of personnel access. After the test is completed, the system pressure must be reduced to MAWP, at which time personnel may then access the system.
  - e. Pressure relief device must be provided, having a set pressure not higher than the test pressure plus 50 psig, or 10% of the test pressure, whichever is less.
  - f. Test pressure for the pressure qualification test of pressure systems must not be less than 150% the design pressure for hydrostatic tests, and 110% for pneumatic tests as defined in ASME B31.3 Para's 345.4 and 345.5. For refrigerant systems, the pneumatic pressure must not be less than 110%, and must not exceed 130% of the design pressure as defined in ASME B31.5, Para. 538.4.2.
  - g. Hydrostatic tests must be performed with water. If water is not suitable (could freeze, or cause adverse affects to piping or process), another suitable non-toxic liquid may be used.
  - h. Test instrumentation used to meet the requirements of this document and codes must be calibrated.
  - i. The pressure of the qualification test must be maintained for at least 10 minutes.
  - j. Qualification tests must be witnessed by a LANL inspector meeting the qualifications of the applicable code; contact ADPMSS's Construction Engineering Group for assistance.

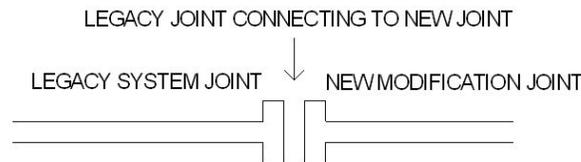
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<sup>67</sup> B31.3-based requirements are presented because the majority of LANL piping systems fall within the scope of B31.3 as defined in B31.3, paragraph 300.1.1

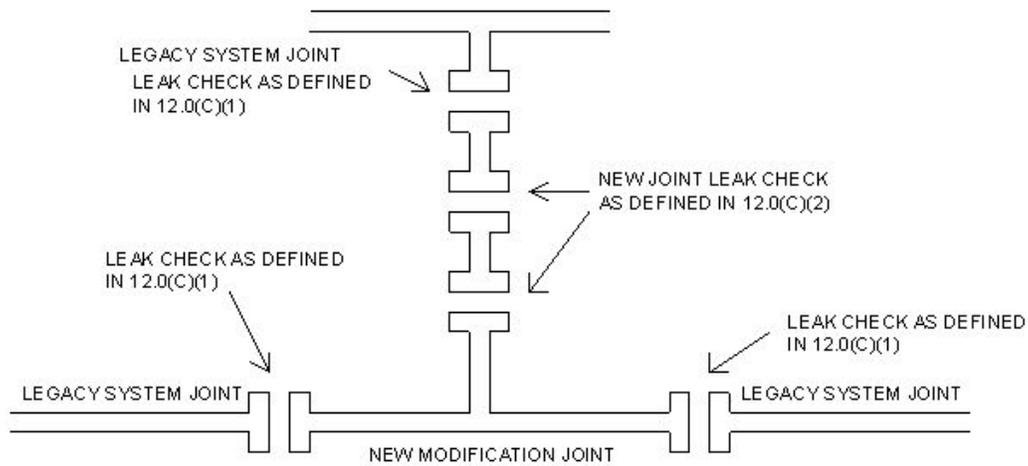
- k. Test procedures and results must be maintained in the system documentation package.

**C. Post Modification /Maintenance Testing**

- 1. For existing (legacy) pressure systems that require system modifications, or any other action which requires the system to be opened and modified by installing a new joint (or removal and replacement of components for calibration purposes), the affected section of piping must be tested/examined as follows (illustration of joint shown below):



- a) For welded connections where elevated pressure leak test is not possible:
  - (1) Full Penetration Weld – Perform volumetric examination (N/A for Cat D per B31.3)
  - (2) Partial Penetration weld – Perform surface examination (N/A for Cat D per B31.3)
  - (3) Perform Initial Service Leak Test as follows:
    - i) Gradually increase pressure in steps until the operating pressure (maximum pressure during normal system operating conditions) is reached, holding the pressure at each step long enough to equalize piping strains.
    - ii) Between each pressure step, examine the affected joints for indications of leaks.
- b) For welded connections which can be leak tested at elevated pressure:
  - (1) CPSO must approve test method and test pressure.
- c) For mechanical (e.g., threaded, flanged) connections:
  - (1) Fluid Category M systems: CPSO must approve test method.
  - (2) All other fluid category systems: Perform in-service leak test as described in a)(3) above.
- 2. Pressure systems that that are modified as stated in 12.0(C)(1) above, but include new joints connecting to new joints (not existing construction) must undergo a code required leak test as defined in the most applicable code. (e.g. B31.3 Part 345). Example illustration shown below.



**D. Inspection/Testing Intervals**

1. Use the following tables for determining the inspection intervals for pressure vessels, relief devices, and piping.<sup>68</sup> Perform vessel inspections per ESM Chapter 17 [ITM-342-1701](#), Pressure Vessel Inspection and Test, using CPSO approved organization(s), e.g., QA-PM.

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<sup>68</sup> Basis for frequencies documented in EM Ref-59.

**Table 13-1 Pressure Vessels Exempt from Mandatory Periodic Test/Inspection<sup>69</sup>**

<p>Vessels listed as exempt from the scope of ASME Section VIII, Division 1. Excerpts:</p> <p>U-1(f) a vessel for containing water<sup>70</sup> under pressure, including those containing air the compression of which serves only as a cushion, when none of the following limitations are exceeded:</p> <ul style="list-style-type: none"> <li>(1) a design pressure of 300 psi (2 MPa);</li> <li>(2) a design temperature of 210°F (99°C);</li> </ul> <p>(g) a hot water supply storage tank heated by steam or any other indirect means when none of the following limitations is exceeded:</p> <ul style="list-style-type: none"> <li>(1) a heat input of 200,000 Btu/hr (58.6 kW);</li> <li>(2) a water temperature of 210°F (99°C);</li> <li>(3) a nominal water containing capacity of 120 gal (450 L);</li> </ul> <p>(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)]:</p> <ul style="list-style-type: none"> <li>(1) vessels having an internal or external pressure not exceeding 15 psi (100 kPa);</li> <li>(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)];</li> </ul> <p>(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;</p> <p>(j) pressure vessels for human occupancy.<sup>71</sup></p> <p>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:</p> <p>U-1(j)(1) 5 cu ft (0.14 m<sup>3</sup>) in volume and 250 psi (1.7 MPa) design pressure; or</p> <p>U-1(j)(2) 3 cu ft (0.08 m<sup>3</sup>) in volume and 350 psi (2.4 MPa) design pressure;</p> <p>U-1(j)(3) 11.2 cu ft (0.04 m<sup>3</sup>) in volume and 600 psi (4.1 MPa) design pressure.</p> <p><b><u>NOTE: Exemption must not be used if corrosion is anticipated or detected</u></b></p>
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<sup>69</sup> Based on 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.

<sup>70</sup> 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

<sup>71</sup> Requirements for pressure vessels for human occupancy are covered by ASME PVHO-1

Table 13-2 Inspection Frequencies for Non-Exempt Pressure Vessels

Service	External + wall thickness (e.g, ultrasonic)	Internal
Corrosive	3	5
Non-corrosive	5 <sup>72</sup>	10 <sup>73</sup>

- a. Boilers: One exception to the above inspection intervals is boilers. Boilers must be inspected according to New Mexico Administrative Code (NMAC) [14.9.4.25](#), “Inspection Methods and Frequency.” 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.<sup>74</sup>
  - i. When the construction does not permit an internal inspection, one external inspection annually is required.
  - ii. Annual internal inspection is required for high-pressure boilers and high pressure steam generators.
  - iii. Every 24 months an external and internal inspection must be performed on the following:
    - a) Direct fire steam jacketed kettles
    - b) Low-pressure steam boilers
    - c) Low-pressure hot water heating boilers
2. The following table indicates pressure relief device test (set point verification) and replacement intervals.

<sup>72</sup> The requirement for wall thickness measurement of vessels in non-corrosive service may be waived if inspection data indicates that no wall thinning is occurring.

<sup>73</sup> Except where API 510 or NBIC allows on-stream [external and wall thickness] in lieu of internal inspection (excerpt below 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.

<sup>74</sup> At the date of release of this document, LANL is not considered exempt from this state regulation. See ESM Ch 1 Section Z10 Codes and Standards subsection.

Table 13-3 Pressure Relief Device Maintenance Intervals

Fluid Service/Type ( <u>alphabetical</u> for PRVs; rupture disks at bottom)	Test Frequency (Years) <sup>75</sup>	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 environs	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
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
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 Damage Ratio is greater than 1.0**	2	Replace	Replace
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
<p>NOTES:</p> <p>** If installation direction cannot be verified or the damage ratio is <math>\geq 1.0</math>, disk must be replaced every 2 years.</p> <p>Basis for table is EMRef-58 (EMRef is a Standards Program system for maintaining references/bases)</p>			

<sup>75</sup> 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 CMMS.

3. Testing of pressure relief valve 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<sup>76</sup>.
4. Any relief valve 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.<sup>77</sup>
5. Regardless if the relief valve is ASME Code stamped (UV) or not, where in-place set-point testing of relief valves is the preferred method of testing, the system must be provided with a traceable calibrated gage. 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 valves (regardless of UV stamp) must be performed by a LANL approved, and designated relief device testing facility.
6. 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)

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<sup>76</sup> See ASME PTC-25 for relief device testing requirements.

<sup>77</sup> See ASME Section VIII, Division 1, Part UG-131.

7. *Guidance: LANL preventative maintenance procedures (PMIs) [adopted from former Site Support Subcontractor (KSL)] related to pressure relief devices are available at the following links:*

- [40-25-039 Boiler Relief Valve Testing \(pdf\)](#)
- [40-25-040 Pressurized Tank Relief Valve Testing \(pdf\)](#)
- [40-25-041 Pressurized Vessel Relief Valve Testing \(pdf\)](#)

8. Pressure relief valves (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 (2.5.7):

Fluid System	Fluid medium used to test valve
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

**E. 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:<sup>78</sup>

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

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

Where:

$t_{\text{actual}}$  = The actual minimum thickness determined at the time of inspection

$t_{\text{initial}}$  = Initial thickness (long-term corrosion rate) or thickness measured in a previous inspection (short-term corrosion rate)

$t_{\text{reqd}}$  = the required minimum thickness

time= time between thickness measurements

#### F. CMMS Database (PassPort, becoming Asset Suite)

1. 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:
  - a. The following data fields are required to be entered for all pressure protection items:
    - i. Pressure system identification/inventory database number.
    - ii. Location
    - iii. Component I.D. number string (CLI number)
    - iv. Component Description
    - v. Op-System (for programmatic, allowing PXXXXX code, where “X” is the system I.D. number including any leading zeros on the ID tag)
    - vi. Working Fluid
    - vii. Fluid Service (FS) code
    - viii. Manufacturer (and model number)
    - ix. Next inspection/test due date.
    - x. Class: Management Level
    - xi. Inspection/Test frequency

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<sup>78</sup> API 570 “Piping Inspection Code”, Section 7 and NBIC Part-2, Para. 4.4.7.2

- b. Additional data for pressure vessels
  - i. National Board number
  - ii. Maintenance Program Code (“P” for pressure vessels, “R” for relief devices)
  - iii. Type of inspection or Model Work Order (UT, RT, etc)

#### G. 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.

#### H. 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 pressure relief, or pressure safety valves 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” stamp.

### 14.0 DOT, IM, and UM Portable Tanks

#### A. Special Instructions for DOT-4L Cylinders<sup>79</sup>

WARNING: A cylinder used for CO<sub>2</sub> service must remain CO<sub>2</sub> service and must not be used for other gas products, especially oxygen or nitrous oxide.

1. Follow the manufacturer’s instructions for service and maintenance

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<sup>79</sup> Chart Industries, Inc., “Liquid Cylinder” Users Manual P/N 10642912 Date:12/00

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2. Excessive loss of product or excessive build-up of pressure is an indication of possible loss of vacuum in the vacuum jacket. Follow the manufacturer's instructions for troubleshooting.
3. If frost spots appear in a non uniform manner, or are in miscellaneous areas the cylinder may have internal damage and will need to be removed from service until repaired (call cylinder manufacturer for details.)
4. Relief devices must be maintained as defined in this document
5. Where manufacturer recommends checking the set point of relief devices in place, the method must be performed as defined in this document.
6. Solidified contents in cylinders (CO<sub>2</sub>) must be re-liquefied per the manufacturer's instructions.

**B. Inspection Frequencies**

1. Records of DOT, IM, and UM vessel inspection and certification reports must be made available upon request.
2. Owners of DOT, IM, and UM vessels must maintain their DOT vessels certified within the inspection interval frequency.
3. DOT, IM, or UM vessels that are not permanently installed in a pressure system must comply with the retest frequencies in CFR Title 49, 180.209. The following table displays the inspection frequencies and retest pressure for cylinders, but does not contain all the requirements of the CFR. The system owner is advised to carefully review the applicable sections.

Table 14-1 Cylinder Inspection Frequencies and Retest Pressures

Specification under which cylinder was made	Minimum retest pressure (psig)	Retest period (years)
DOT-3	3000 psig	5
DOT-3A, 3AA	5/3 times service pressure, except non-corrosive service *	5, 10, or 12 *
DOT-3AL	5/3 times service pressure	5 or 12 *
DOT-3AX, 3AAX	5/3 times service pressure	5
3B, 3BN	2 times service pressure	5 or 10 *
3C	Retest not required	Retest not required
3D	5/3 times service pressure	5
3E	Retest Not Required	Retest not required
3HT	5/3 times service pressure	3 *
3T	5/3 times service pressure	5
4	700 psig	10
4A	5/3 Times service pressure *	5 or 10 *
4AA480	2 times service pressure	5 or 10 *
4B, 4BA, 4BW, 4B-240ET	2 times service pressure except non-corrosive*	5, 10, or 12 *
4C	Retest not required	Retest not required
4D, 4DA, 4DS	2 times service pressure	5
DOT-4E	2 times service pressure except non-corrosive*	5
4L	Retest not required	Retest not required
8, 8AL	-	10 or 20*
DOT-9	400 psig (maximum 600)	5
25	500 psig	5
26 (for filling over 450 psig)	5/3 times service pressure	5
26 (for filling at 450 psig)	2 times service pressure	5
33	800 psig	5
38	500 psig	5
Special Permit Cylinder	See current special permit.	See current special permit
Foreign Cylinder (see CFR Title 49 section 173.301(j) for restrictions on use).	As marked on the cylinder, but not less than 5/3 of any service or working pressure marking.	5
*See CFR Title 49 Section 173.34(e) for specific instructions for types of vessels.		

- The following table displays the NBIC inspection frequencies for DOT, IM, and UM portable tanks and vessels. Portable vessels must be maintained within their inspection due dates.<sup>80</sup>

<sup>80</sup> NBIC Part-2 Table S6.14, Inspection Intervals

**Table 14-2 Portable Tank and Vessel Inspection Frequencies (DOT, IM, and UM)**

Specification	Periodic Inspection and Test	Intermediate Periodic Inspection and Test
UM or UN Portable Tanks once placed in service	5 years	2-1/2 years
DOT 51 Portable Tanks	5 years	-
DOT 56 or DOT 57 Portable Tanks (the first periodic inspection and test is required 4 years after being placed into service and each 2-1/2 years thereafter.)	2-1/2 years	-
DOT 60 Portable Tanks (the first periodic inspection and test is required 4 years after being placed into service and the per the schedule to the right)	For the first 12 years of service, every 2 years.	After 12 years of service, yearly.
Retesting is not required on a rubber lined tank, except before relining.		
For IM and UN Portable Tanks, periodic inspection and test must include at least an internal and external of the portable tank and fittings, taking into account the hazardous material intended to be transported.		

## 15.0 Mobile Pressure Systems and Transport Tanks

### A. Definitions

1. LANL owned mobile pressure vessels and tanks [to include Category 406 (4 psi)] are subject to the requirements of this document which are included within the scope of ASME Section XII. These systems and vessels include, but are not limited, to the following:
  - a. Portable tanks for transporting cryogenic fluids (greater than 120 gallons), not part of a Road-Tank vehicle.
  - b. Rail Tanks
  - c. Cargo Tanks – Intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures. Is permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which by reason of its size, construction, or attachment to a motor vehicle is loaded or unloaded without being removed from the motor vehicle. Is not fabricated under a specification for cylinders, portable tanks, tank cars, or multi-unit tank car tanks.
2. Pressure vessel designs within the scope of Section XII are as follows:
  - a. Full vacuum to 3000 psig
  - b. Temperature range is between -452°F to 650°F
  - c. Thickness of shells and heads does not exceed 1.5 inches.

### B. Procurement

1. Transport tanks must be procured with the ASME (T) stamp symbol.

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2. Mobile pressure systems and transport tanks that do not bear the ASME stamp symbol must be evaluated as equivalent through engineering calculations.

**C. Pressure Relief Devices**

1. Must comply with the tolerances and capacities as defined by ASME Section VIII, and must be installed as defined in ASME Section XII, paragraph TR-130
2. Must be tracked in the CMMS (“PassPort”) database as defined by this document
3. Must be code stamped relief devices (TV) or (TD). ASME Section VIII stamped components are authorized to be used on (T) stamped vessels provided the requirements of Section XII are met as defined in ASME Section XII, Article TG-120.2.
4. Must comply with the re-test/replace intervals, as specified in this document.

**D. Piping, Valves, and Fittings**

1. Each connection must be clearly labeled to indicate its function
2. Piping, valves and fittings must be grouped and protected from damage.
3. Must comply with ASME B31.3 as defined by ASME Section XII

**E. Pressure System Documentation Package**

1. The manufacturer’s data report (T-1A, B, or C) and/or partial data report must be maintained in the pressure system documentation package.
2. Relief valve calculations, recall date, and set pressure must be documented and maintained in the pressure system documentation package.
3. Repairs and alterations must be documented and maintained in the pressure system documentation package.
4. Records of inspections must be maintained in the pressure system documentation package as defined in ASME Section XII, Article TP-6.

**F. Repairs and Alterations**

1. Must be performed by an institution holding the (TR) stamp.
2. Repairs and alterations must be performed in accordance with NBIC/NB-23
3. Must be performed as defined in ASME Section XII Part TP

**G. Tests and Inspections**

1. Testing and Inspection must be performed as defined in ASME Section XII, Articles TP-4, and TP-5.

### 16.0 Pressure System Documentation Package Contents

Tables 16-1 and 16-2 below summarize the pressure system documentation package contents for existing (legacy) systems and new systems, respectively.

**Table 16-1  
Documentation Requirements for Existing (Legacy) Systems<sup>81</sup>**

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 3, Code Non-Compliance Log (Form can be printed from Pressure Safety Database by PSO)	If Applicable		
3. Form 4, Minor Non-Compliance Log (Form can be printed from Pressure Safety Database by PSO)	If Applicable		
4. System schematics (If the owner does not have a system schematic, utilize the sketch prepared by the walkdown team until such time as system schematic is prepared) <sup>82</sup>	Every Package		
5. Alternate Method/Variance or clarification/interpretation (if applicable). See Article 2.0 (D) of this document.	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		

<sup>81</sup> The requirements for existing systems reflect the graded approach described in other sections of this Chapter, and take credit for successful operating history.

<sup>82</sup> Information required on system schematics may be documented in alternative documents or captured in controlled databases, such as the Master Equipment List (MEL) or Computerized Maintenance Management System (CMMS), but must be referenced and readily available for review. The evaluation shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2

Documentation Package Item	Required When	Owner Verification	PSO Verification
6. Code Stamped Vessel Fabrication Documentation	<p>If the code data report is not available, a manufacturer’s construction drawing may be used to verify the item has not been modified.</p> <p>If the manufacturer’s construction drawing is not available, personal knowledge may be used to establish the code stamped item has not been modified. This requires a person or persons with intimate and long term personal knowledge since original receipt and installation of the item to create a statement of compliance. This statement of compliance will be used to document the history of the item and be used as evidence the code stamped item has not been modified. This statement of compliance will be signed by the persons of record.</p>		
7. Non-ASME code Fabricated Vessel Information (code-equivalent Documentation)	The pressure system contains Non-ASME-code stamped boilers and pressure vessels (which includes boilers, pressure vessels, heat exchangers, and accumulators)		
a. ASME code equivalent documentation for systems with pressure vessels which includes but is not limited to minimum wall thickness determination, corrosion allowance, weld efficiency rating, support structure loading, nozzle calculations. Calculations will use the material values specified in the ASME code.	A non-code boiler, pressure vessel, heat exchanger or accumulator is in the pressure system package		
b. Pressure Qualification Test Procedures and data	Non-code boiler, pressure vessel, heat exchanger or accumulator is in the pressure system package		
c. Modification procedures/instructions	Modifications were made to non-code boilers, pressure vessels, heat exchangers or accumulators is in the pressure system package		
d. Non-Destructive Evaluation (NDE) data reports	NDE was done to non-code boilers, pressure vessels, heat exchangers or accumulators is in the pressure system package		
e. Weld examination forms as described in ESM Chapter 13.	Welding was done to non-code boilers, pressure vessels, heat exchangers or accumulators is in the pressure system package		
f. Special Calculations such as welding	Special calculations are performed for non-code boilers, pressure vessels, heat exchangers or accumulators is in the pressure system package		
g. Vendor Drawings	Piece parts are used to fabricate non-code boilers, pressure vessels, heat exchangers or accumulators is in the pressure system package		
h. Vessel modification reports	Vessel is modified by other than LANL personnel		

Documentation Package Item	Required When	Owner Verification	PSO Verification
8. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. Flow Test documentation as described in this Chapter, if required	Whenever a relief valve has been modified, or when calculations cannot be generated.		
b. Safety Relief Calculations for relief valves, in accordance with ASME requirements	Every Package, unless calculations cannot be generated, a flow test is required in place of calculations.		
c. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
d. Certified Test Data of relief valves, e.g. steam Pressure safety valves are certified by NBIC coded shop	A PRD is modified or tested by an outside facility		
e. Documentation of relief valve modification, if required	If a relief valve has been modified		
f. Identification as a liquid lock PRD on PRV Recall Summary Sheet and pressure system Component List spread sheet.	PRDs are used as protection against liquid lock overpressure.		
9. Piping System Documentation:			
a. Provide documentation required under Section 10.0 requirements for “Pressure System Deficiency Disposition Requirements for Existing Pressure Systems”	The system contains pipe, tube, or other components not classed as boilers or vessels.		
b. Code required calculations e.g. flexibility analysis, pipe supports, wind loading, and seismic loading. see specific code for additional detail. (e.g. B31.3 paragraph 319 and 321)	A pressure system package contains piping system components		
10. Flexible pressure element external visual inspection records (Form 5)	The system contains flexible hoses		
11. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		
12. Oxygen System Hazard Analysis (if applicable)	Pressure system is an oxygen system		

**Table 16-2  
Documentation Requirements for New Systems**

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. All forms contained in Attachment A of this standard <sup>83</sup>	Every Package		
2. System drawings and schematics <sup>84</sup>	Every Package		
3. Alternate Method/Variance (if applicable). See Part 9.0 of this standard.	If the system or any item of the system has an applicable alternate method/variance to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	The system contains a code stamped vessel		
5. Non-ASME code Fabricated Vessel Information (code-equivalent Documentation)	The pressure system contains Non-ASME-code stamped boilers and pressure vessels (which includes boilers, pressure vessels, heat exchangers, and accumulators)		
a. ASME code equivalent documentation for systems with pressure vessels which includes but is not limited to minimum wall thickness determination, corrosion allowance, weld efficiency rating, support structure loading, nozzle calculations. Calculations will use the material values specified in the ASME code.	A non code boiler, pressure vessel, heat exchanger and accumulator is in the pressure system package		
b. Pressure Qualification Test Procedures and data	Non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		

<sup>83</sup> Information required on the forms in Attachment A may be documented in alternative documents or captured in controlled databases, such as the MEL or CMMS, but must be referenced and readily available for review. The evaluation shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2

<sup>84</sup> Information required on system drawings and schematics may be documented in alternative documents or captured in controlled databases, such as the MEL or the CMMS, but must be referenced and readily available for review. The evaluation shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2

Documentation Package Item	Required When	Owner Verification	PSO Verification
c. Modification procedures/instructions	Modifications were made to non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		
d. Non-Destructive Evaluation (NDE) data reports	NDE was done to non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		
e. Weld examination forms as described in ESM Chapter 13.	Welding was done to non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		
f. Special Calculations such as welding	Special calculations are performed for non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		
g. Vendor Drawings	Piece parts are used to fabricate non code boilers, pressure vessels, heat exchangers and accumulators is in the pressure system package		
h. Vessel modification reports	Vessel is modified by other than LANL personnel		
6. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. Flow Test documentation as described in this Chapter	Whenever a relief valve has been modified, or when calculations cannot be generated.		
b. Safety Relief Calculations for relief valves, in accordance with ASME requirements	Every Package, unless calculations cannot be generated, a flow test is required in place of calculations.		
c. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
d. Thermal Load Calculations (Fire Sizing)	A relief device is used to protect against thermal induced over pressure.		
e. Certified Test Data of relief valves, e.g. steam Pressure safety valves are certified by NBIC coded shop	A PRD is modified or tested by an outside facility		
f. Documentation of relief valve modification	If a relief valve has been modified		
g. Identification as a liquid lock PRD on PRV Recall Summary Sheet and pressure system Component List spread sheet.	PRDs are used as protection against liquid lock overpressure.		
7. Piping System Documentation	The system contains pipe, tube, or other components not classed as boilers or vessels.		
a. Fabrication Documentation	Code equivalent systems must have records of all fabrication, inspection, test, and design data required by the applicable code.		

Documentation Package Item	Required When	Owner Verification	PSO Verification
b. Pressure Qualification Test Procedures and data as defined by the applicable piping code	A pressure system package contains piping system components		
c. Modification procedures/instructions	Components of a system were modified from original construction		
d. Non-Destructive Evaluation (NDE) data reports	NDE is performed on piping system components		
e. Special Calculations such as Welds and Orifices	A pressure system package contains piping system components that have been welded, modified with "home-made" orifices, or unlisted components.		
f. Corrosion allowance calculations per ASME B31G	Piping is used in corrosive fluid service		
g. Code required calculations e.g. flexibility analysis, pipe supports, wind loading, and seismic loading. see specific code for additional detail. (e.g. B31.3 paragraph 319 and 321)	A pressure system package contains piping system components		
h. Weld examination forms in accordance with ESM Chapter 13, and special required examinations defined in the applicable code.	Welding of pipe or tube in a pressure system package was performed		
i. Weld In-Process Forms in accordance with ESM Chapter 13, and the most applicable code.	When in-process examination of welding is used		
j. Vendor Drawings or sketches	A pressure system package contains vendor supplied systems, piping, or components		
8. Flex-hose external visual inspection records (see attached forms)	The system contains flexible hoses		
9. Pump or compressor discharge pressure curves, calculation, or table	The pressure system contains pumps or compressors		
10. Oxygen System Hazard Analysis	Pressure system is an oxygen system		

## **17.0 Appendices**

- A. 10CFR851 Appendix A, Part 4 Pressure Safety**
- B. ASME Codes, Standards, and LANL CENG References**
- C. Forms**
- D. Relief Device Selection Process for Gas Bottle Systems**
- E. Risk-Based Engineering Evaluation of Legacy Pressure Systems**
- F. Category M Fluids**

**A. Appendix A – 10CFR851, Appendix A, Part 4, Pressure Safety**

- (a) Contractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, repaired, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.
- (b) Contractors must ensure that all pressure vessels, boilers, air receivers, and supporting piping systems conform to:
- (1) The applicable American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (2004); sections I through section XII including applicable Code Cases (incorporated by reference, see § 851.27)
  - (2) The applicable ASME B31 (Code for Pressure Piping) standards as indicated below; and or as indicated in paragraph (b)(3) of this section:
    - (i) B31.1—2001—Power Piping, and B31.1a—2002—Addenda to ASME B31.1—2001 (incorporated by reference, see § 851.27);
    - (ii) B31.2—1968—Fuel Gas Piping (incorporated by reference, see § 851.27);
    - (iii) B31.3—2002—Process Piping (incorporated by reference, see § 851.27);
    - (iv) B31.4—2002—Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids (incorporated by reference, see § 851.27);
    - (v) B31.5—2001—Refrigeration Piping and Heat Transfer Components, and B31.5a—2004, Addenda to ASME B31.5—2001 (incorporated by reference, see § 851.27);
    - (vi) B31.8—2003—Gas Transmission and Distribution Piping Systems (incorporated by reference, see § 851.27);
    - (vii) B31.8S—2001—Managing System Integrity of Gas Pipelines (incorporated by reference, see § 851.27);
    - (viii) B31.9—1996—Building Services Piping (incorporated by reference, see § 851.27);
    - (ix) B31.11—2002—Slurry Transportation Piping Systems (incorporated by reference, see § 851.27); and
    - (x) B31G—1991—Manual for Determining Remaining Strength of Corroded Pipelines (incorporated by reference, see § 851.27).
  - (3) The strictest applicable state and local codes.
- (c) When national consensus codes are not applicable (because of pressure range, vessel geometry, use of special materials, etc.), contractors must implement measures to provide equivalent protection and ensure a level of safety greater than or equal to the level of protection afforded by the ASME or applicable state or local code. Measures must include the following:
- (1) Design drawings, sketches, and calculations must be reviewed and approved by a qualified independent design professional (i.e., professional engineer). Documented organizational peer review is acceptable.
  - (2) Qualified personnel must be used to perform examinations and inspections of materials, in-process fabrications, nondestructive tests, and acceptance test.
  - (3) Documentation, traceability, and accountability must be maintained for each pressure vessel or system, including descriptions of design, pressure conditions, testing, inspection, operation, repair, and maintenance.

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**B. Appendix B – ASME Codes, Standards, and LANL Conduct of Engineering References**

1. Boiler and Pressure Vessel Sections

- |   |   |
|---|---|
| Section I – Rules for Construction of Power Boilers   | Section V – Nondestructive Examination  |
| Section II Materials, Part A – Ferrous Material Specifications  | Section VI - Recommended rules for the care and operation of heating Boilers  |
| Section II Materials, Part B – Nonferrous Material Specifications   | Section VII – Recommended guidelines for the care of power boilers  |
| Section II Materials, Part C – Specifications for Welding Rods, Electrodes, and Filler Metals   | Section VIII, Division 1 – Rules for construction of pressure vessels   |
| Section II Materials, Part D – Properties (Customary and Metric)  | Section VIII Division 2 – Alternative rules for construction of pressure vessels  |
| Section III – Rules for Construction of Nuclear Facility Components NCA General Requirements for Division 1 and 2.  | Section VIII, Division 3 – Alternative rules for construction of high pressure vessels (10,000 psig or greater)             |
| Section III, Division 1 – Rules for Construction of Nuclear Facility Components   | Section IX – Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators |
| Section III, Division 2 – Rules for construction of Nuclear Facility Components (Code for concrete containments)  | Section X – Fiber-reinforced plastic pressure vessels   |
| Section III, Division 3 – Rules for Construction of Nuclear Facility Components (containments for transportation and storage of spent nuclear fuel and high level radioactive material and waste) | Section XI – Rules for in-service inspection of nuclear power plant components  |
| Section IV – Rules for Construction of Heating Boilers  | Section XII - Rules for construction and continued service of transport tanks   |

2. B31 Piping Codes

Of the 10CFR851 required codes, LANL does not follow B31.2-1968-Fuel Gas Piping (withdrawn by ASME in 1988 so we use NFPA 54 Fuel Gas Code); B31.4-2002-Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids (LANL’s gasoline and propane systems are small, not distribution); B31.11-2002-Slurry Transportation Piping Systems (applies to mining). We follow B31G-1991-Manual for Determining Remaining Strength of Corroded Pipelines, although we normally replace utility scale lines. As of Rev 3 of this document, these determinations were documented in LANL [SD100](#), Integrated Safety Management System Description Document with embedded 10 CFR 851 Worker Safety and Health Program, May 2009.

- |   |   |
|---|---|
| B31.1 – Power Piping                                      | B31.8S – Managing System Integrity of Gas Pipelines                         |
| B31.3 – Process Piping                                    | B31.9 - Building Services Piping  |
| B31.5 – Refrigeration Piping and Heat Transfer Components | B31.12 – Hydrogen Piping  |
| B31.8 – Gas Transmission and Distribution Piping Systems  | B31G – Manual for Determining the Remaining Strength of Corroded Pipelines. |
|   | B31Q – Pipeline Personnel Qualification                                     |

3. Other ASME standards relevant to pressure systems and inspection

- ASME A13.1 – Scheme for the identification of piping systems
- ASME B16.5 – Piping Flanges/Fittings
- ASME B36.10M – Welded and Seamless Wrought Steel Pipe
- ASME B36.19M – Stainless Steel Pipe
- ASME CSD-1 – Controls and Safety devices for automatically fired boilers
- ASME HPS – High Pressure Systems
- ASME PCC-1 – Guidelines for pressure boundary bolted flange joint assembly
- ASME PTC-1 – Performance Test Codes

- ASME PTC 25 – Performance Test Code – Pressure Relief Devices
- ASME PTCMP – Performance monitoring guidelines for steam power plants
- ASME PVHO-1 – Safety Standard for pressure vessels for human occupancy.
- ASME QAI-1 – Qualifications for Authorized Inspection (Authorized Inspection Agencies)
- ASME Y14-38 – Abbreviations and Acronyms for Use on Drawings and Related Documents

4. API (American Petroleum Institute)

- API 510 – Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration
- API 521 – Pressure-relieving and Depressuring Systems

- API 579 – Fitness for Service
- API RP 580 – Risk-Based Inspection

5. ASTM International

- ASTM A 380 – Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- ASTM G 93 – Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

- ASTM G 63 – Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service
- ASTM G88 – Guide for Designing Systems for Oxygen Service
- ASTM G128 – Guide for Control of Hazards and Risks in Oxygen Enriched Systems

6. LANL Conduct of Engineering

- Documents, Administrative Procedures, and Records website:  
<http://int.lanl.gov/orgs/ceng/APs.shtml>

- LANL Engineering Standards:  
<http://engstandards.lanl.gov/>

**C. Appendix C - Forms**

The following forms are samples, provided to illustrate the type of information required; use the latest spreadsheet-based forms posted online with this Chapter 17 Section I in lieu of these Word-based samples or contact CPSO for latest Word forms in native format.

FM01

LANL Pressure System Certification Status Form

(Place this form in pressure system documentation package when completed)

System ID No.: \_\_\_\_\_ Excluded System? \_\_\_\_\_ (Y/N)

Other system Identification name (or number): \_\_\_\_\_

System Location (TA/BLDG/Room) : \_\_\_\_\_ ( not applicable if mobile)

Mobile System "T" number : \_\_\_\_\_ ( not applicable if not mobile)

System Contents: (Nitrogen, Argon, etc) \_\_\_\_\_ (Do not list if classified)

System Fluid Category (FS1, FS2, or FS3): \_\_\_\_\_

Applicable ASME B&PVC Section for System: \_\_\_\_\_ Applicable B31 Code for system: \_\_\_\_\_

System Owner: \_\_\_\_\_ Phone: \_\_\_\_\_

Reviewer Name: \_\_\_\_\_

Approval Signature List – Initial Certification

System Owner \_\_\_\_\_

PSO Initial Review \_\_\_\_\_

PSO Certification \_\_\_\_\_

CPSO Certification \_\_\_\_\_

Approval Signature List – Re-Certification<sup>85</sup>

System Owner \_\_\_\_\_

PSO Initial Review \_\_\_\_\_

PSO Certification \_\_\_\_\_

\_\_\_\_\_

<sup>85</sup> Re-Certification occurs following a major modification to the system

**FM02**

**PRV RECALL SUMMARY SHEET**

SYSTEM NAME AND I.D. NUMBER:

PRESSURE RELIEF DEVICE COMPONENT NUMBER	MANUFACTURER	MODEL NUMBER	MAWP (PSIG)	SET PRESSURE (PSIG)	TEST DATE	DUE DATE	PRV TEST LAB REPORT #	FLOW CHECK PROCEDURE or CALCULATION #

Page \_\_\_ of \_\_\_

PSO Certification:

Date:

**FM03**

**Code Non-Compliance Log<sup>86</sup>**

System I.D. No.:			
System Description:			
Page: _____ of _____			
Description	Code Requirement (section, chapter, paragraph)	Closure & Rationale	Closure Date and LANL PSO Signature

---

<sup>86</sup> Examples are: undersized relief device, wrong set pressure on relief device, weld repairs without “R” stamp, component MAWP less than system design pressure, unsupported piping, unknown materials used in construction, unknown design pressure, failure to perform and document code required inspections and testing, etc.

**FM04**

**Minor Non-Compliance Log<sup>87,88</sup>**

System I.D. No.:				
System Description:				
Page: _____ of _____				
Description	Requirement (LANL Document, Section, Paragraph)	Closure/Rationale	Closure Date and Initials	
			System Owner	PSO

<sup>87</sup> Examples of minor non-compliances are: Relief device past recall due date, in-service inspections past due date , chipped paint, lack of flex-hose restraints, leaking fittings, surface anomalies, identification tags, schematics do not match physical layout, mud dauber nests in relief valve discharge ports

<sup>88</sup> For ML-1 or ML-2 initiate NCR

**FM05**

**Flexible Pressure Element Visual External Examination**

System I.D. Number: \_\_\_\_\_

Date of Inspection: \_\_\_\_\_

PSO Signature: \_\_\_\_\_

Component Number	MAWP (if missing, flexhose is unacceptable)	Integrity		Are Flex-Hose restraints used?	Flex-Hose Restraint	
		ACC (good condition, no visible flaws)	UNACC (kinks, frayed, crushed, etc)	Yes/No	ACC	UNACC

**FM06  
Tubing and Piping Data Sheet<sup>89</sup>**

Pressure System Identification number:		Drawing number:		Date:		
Components that tubing section is located between (e.g. MV-4 and PI-3)  (N/A if all tubing is same size and type throughout the entire pressure system)	Tubing Material (SS, Cu, CS, etc)	Tubing Spec/Grade Specification (316-A26, 304L-A358, etc)	O.D.(in.)	I.D. (in.)	Seamless? (yes/no)	Maximum system operating temperature (Fahrenheit)

<sup>89</sup> This data sheet accomplishes the requirements found in ASME B31.3 Paragraph 323.1.3

**FM07**

**Pressure System Component List<sup>90</sup>**

Pressure system documentation package I.D. number:

System location (TA-BLDG-Room):

Component I.D.	Manufacturer	Model Number	Material (316 S.S., Brass, etc)	MAWP	Soft good material(s) <sup>1</sup>	Code Stamp (U, UV, etc) <sup>2</sup>

<sup>1</sup> Unknown is an acceptable answer for inert systems, where material compatibility is not an issue.

<sup>2</sup> N/A (Not applicable) is an acceptable answer if component is not code stamped

<sup>90</sup> This form accomplishes configuration control requirements, allows for quick viewing of system piping component characteristics and to ensure adequate pressure relief has been provided. Components found on this form must be found on the system drawing, and vice-versa.

**FM08**  
**Pressure Relief Valve Placement Verification Record<sup>91</sup>**

This form is to be maintained in the pressure system documentation package.

1) Perform system review. Identify placement of all components in the pressure system in relationship to a pressure relief device. Can any components be isolated from a pressure relief device? (i.e. can a valve be closed which blocks flow path to a relief device?)

Yes \_\_\_ No \_\_\_

List below, all the components that can be isolated from a pressure relief device. (attach sheets as necessary)

- a) \_\_\_\_\_ b) \_\_\_\_\_ c) \_\_\_\_\_ d) \_\_\_\_\_  
 e) \_\_\_\_\_ f) \_\_\_\_\_ g) \_\_\_\_\_ h) \_\_\_\_\_

2) Is the MAWP, of any of the above identified components, less than the system source supply pressure?

Yes \_\_\_ No \_\_\_

If yes, list components below, and re-design system to provide over pressure protection for the listed components.

Component I.D.	Manufacturer	Model	MAWP (psig)

PSO signature \_\_\_\_\_ Date \_\_\_\_\_

PSO verification (after action completed, or verified) \_\_\_\_\_ Date \_\_\_\_\_

System Owner Signature (sign when action completed) \_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_

<sup>91</sup> This data sheet accomplishes the requirements of ASME B31.3 Paras. 301.2.1, 301.2.2

Section I

Rev. 3, 5/12/2010

**FM09  
Thrust Consideration Data Sheet<sup>92</sup>**

This form is to be used for all manual valves, nozzles, relief devices, solenoid valves, (etc.) in a system that discharge to the ambient surroundings.

Component Identification String	Fluid	I.D. of nozzle/tubing at discharge (inches)	Maximum source pressure (PSIG)	Maximum surge/sustained thrust (lbf)	Type of Restraint Mechanism (if any) Installed.	Maximum Loading (lbs) Restraint Can Withstand <sup>93</sup>
				/		
				/		
				/		
				/		
				/		

<sup>92</sup> This Data Sheet accomplishes the requirements of ASME B31.3 Paragraph 301.5.5, 322.6.2, and Appendix G

<sup>93</sup> As determined by manufacturers' documentation, Finite Element Analysis, calculations, catalog description, etc.

Section I

Rev. 3, 5/12/2010

**FM10**  
**Relief Device Sizing Sketch Sheet (Sample)**

Sketch below the portion of the relief system to be analyzed. Sketch must be an accurate representation of physical relief system layout with dimensions. Use additional sheets for additional relief devices. Do not sketch multiple relief systems on a single sheet. CAD drawings may be attached to this sheet\*.

System I.D.#	Relief Device Component I.D.	Sketcher/Evaluator Name	Date

**D. Appendix D – Relief Device Selection Process for Gas Bottle Systems**

This appendix provides a sample calculation to illustrate the methodology to be used to size a relief device for a gas bottle system. This sample calculation uses information contained in Ares calculation number 0633301.52-M-062, which is available via the following link at the Pressure Protection Program Website: [http://int.lanl.gov/orgs/es/pp/docs/stampedcalc0633301\\_52-m-062\\_r3\\_lanl-accepted.pdf](http://int.lanl.gov/orgs/es/pp/docs/stampedcalc0633301_52-m-062_r3_lanl-accepted.pdf)

This sample calculation evaluates two cases: (1) without a restriction orifice, and (2) with a restriction orifice.

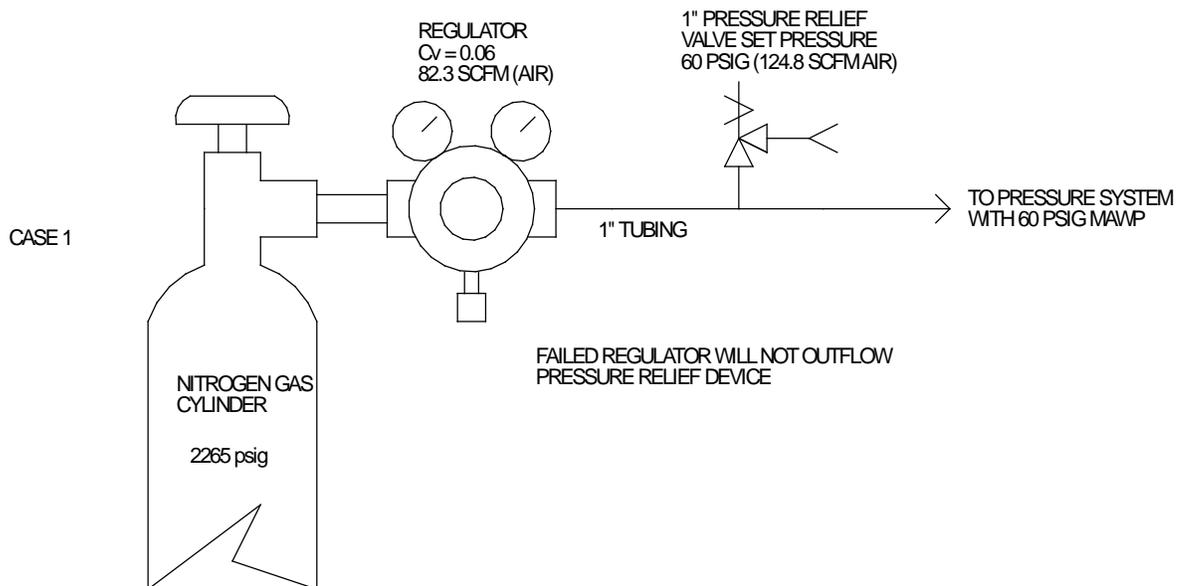
The following design parameters are assumed for this pressure system:

Gas Bottle: Nitrogen at 2265 psig

Regulator: Scott model 51-3300E-CGA, with a  $C_v = 0.06$

Regulator downstream MAWP = 60 psig

Relief valve set pressure = 60 psig



Case 1

From the Ares calculation (page 9), the flow,  $Q_{air\_nitrogen} = 82.3$  scfm for a  $C_v = 0.06$

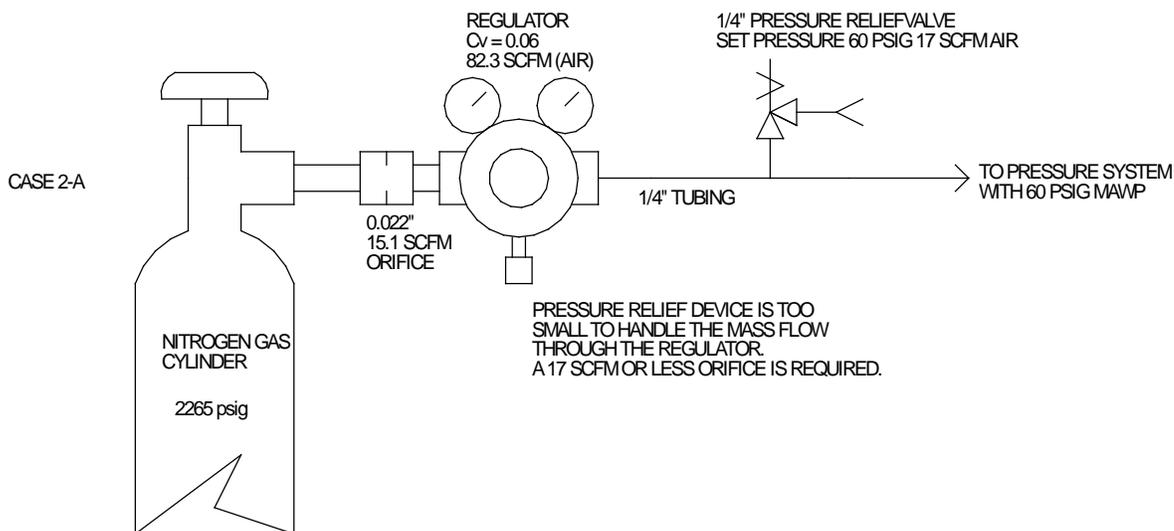
Regulator downstream pipe size: 1 inch

For valve selection, refer to the capacity data for Kunkle Relief Models 264 through 267 (ASME Section VIII, Air/Gas and Steam, National Board Certified). Valve inlet sizes: 1/2", 3/4", 1". Refer to Kunkle catalog at: <http://www.kunklevalve.com/catalog/264.pdf>

The capacity data sheet provides the following flows as a function of the setpoints:

Set Pressure (psig)	Flow (Air) (scfm)
50	108
75	150

Interpolating for a set pressure of 60 psig, yields a flow of 124.8 scfm, which is greater than the required flow of 82.3 scfm.



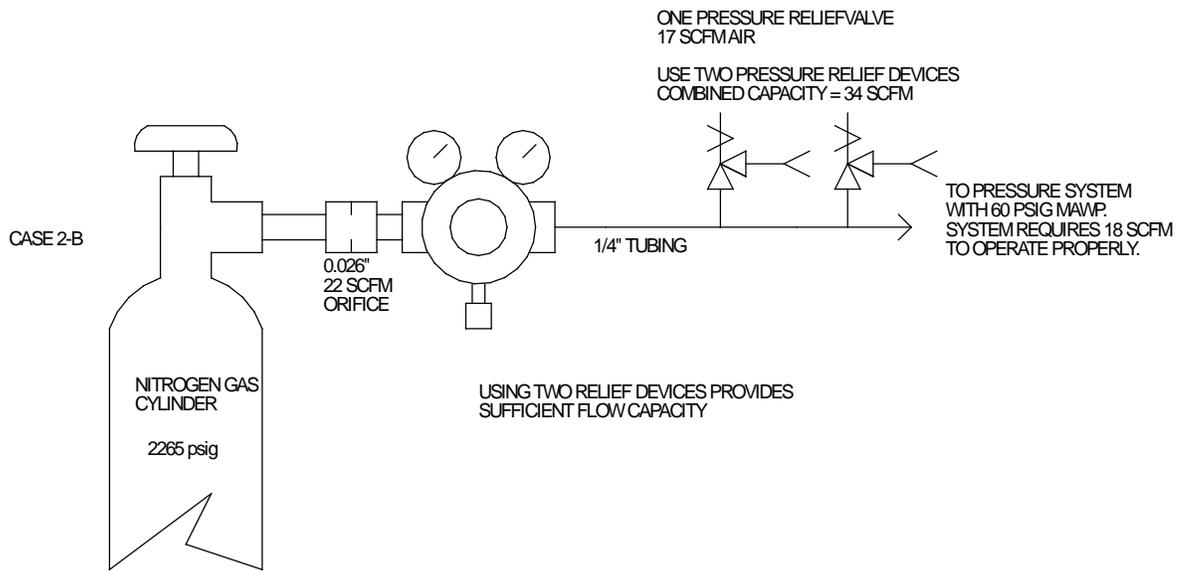
Case 2-A

Regulator downstream pipe size: ¼ inch

82.3 scfm is too large for a ¼ inch relief valve; consequently, a restriction orifice will be added upstream of the regulator.

Assume that a ¼ inch Circle Seal model D500-M relief valve is available. The capacity data sheet for that valve indicates a flow of 17 scfm (air) at a setpoint of 60 psig (size 2M at 10% accumulation). Refer to Circle Seal catalog at: [http://www.circleasealcontrols.com/products/relief\\_valves/500/500-series\\_2007-10\\_lo.pdf](http://www.circleasealcontrols.com/products/relief_valves/500/500-series_2007-10_lo.pdf)

From the Ares calculation (page 12), the flow,  $Q_{air\_nitrogen} = 15.1$  scfm for an orifice diameter of 0.22 inch. The orifice flow of 15.1 scfm is within the relief valve capacity of 17 scfm.



Case 2-B

Regulator downstream pipe size: 1/4 inch

Assume that a flow of 18 scfm (air) is required to meet the demands of the downstream system.

From the Ares calculation (page 12), the flow, an orifice diameter of 0.026 allows a flow,  $Q_{air\_nitrogen} = 22.0$  scfm.

ASME B31.3, section 322.6.3, references ASME Section VIII, UG-134, which allows multiple pressure relief valves.

Using two Circle Seal model D500-M (1/4" inlet at 10% accumulation) provides a total flow of 34 scfm (air) at a setpoint of 60 psig, which exceeds the orifice flow of 22.0 scfm.

**E. Appendix E – Risk-Based Engineering Evaluation of Legacy Pressure Systems****1. Definitions**

- 1.1. **Engineering Evaluation** – The Risk-Based Engineering Evaluation is the process of reviewing a pressure system for adequate pressure system integrity and determining necessary corrective actions to mitigate risk to acceptable level based on best engineering practices.
- 1.2. **Consequence** – The potential outcome from an event. There may be more than one consequence from an event.
- 1.3. **Probability** – The relative frequency with which an event is likely to occur within the time frame under consideration.
- 1.4. **Acceptable Risk** – A Qualitative Risk (QR) number of 4 or higher as shown on Table E-3, Qualitative Risk.

**2. Baseline Criteria**

- 2.1. The Risk-Based Engineering Evaluation applies only to systems that have correctly sized relief protection.
- 2.2. The Risk-Based Engineering Evaluation applies only to legacy systems built prior to March 10, 2009. All other systems are required to meet ESM Chapter 17 requirements for new construction.

**3. Engineering Evaluation**

- 3.1. The Risk-Based Engineering Evaluation is a three step process. This process applies to evaluation of Risk Level 2 and 3 deficiencies, as defined in Section 10.0 of this Chapter; Risk Level 1 deficiencies must be corrected in accordance with the requirements stipulated in Section 10.0.
  - 3.1.1. Using system information generated from the walk down team efforts and other sources, and ESM Chapter 17 requirements, the engineer generates a Qualitative Risk of each deficiency.
  - 3.1.2. The Qualitative Risk is then compared to the Acceptable Risk (i.e., risk number of 4 or higher).
  - 3.1.3. If the Qualitative Risk is greater than the Acceptable Risk (i.e. a risk number lower than 4) either the consequence or probability must be adjusted to achieve a risk number of 4 or higher.
- 3.2. An engineering evaluation of the pressure system shall be performed by personnel meeting the qualification requirements for a pressure system designer (Section 3.0.A) and approved by a qualified PSO (Section 3.0.C) with Risk Evaluation training.
- 3.3. The engineering evaluation shall be an analysis and examination of the pressure system to determine the system integrity.
- 3.4. The Risk-Based Engineering Evaluation analysis shall be included with the pressure system documentation.
- 3.5. The Risk-Based Engineering Evaluation shall ensure that hazards and dominant contributors to risk are controlled according to the following:
  - 3.5.1. Eliminate accident scenarios (e.g., eliminate hazards or initiating events by design).
  - 3.5.2. Reduce the likelihood of accident scenarios through design and operational changes (hazard control).
  - 3.5.3. Reduce the severity of accident consequences (hazard mitigation).
  - 3.5.4. Improve the state-of-knowledge regarding key uncertainties that drive the risk associated with a hazard (uncertainty reduction to support implementation of the above strategies).
- 3.6. The control(s) shall be based on the level of risk associated with that hazard. Some risks may require a combination of several different approaches to prevent, mitigate, and/or control the risk.
- 3.7. Controls shall be applied in the following order of precedence:
  - 3.7.1. engineered controls,
  - 3.7.2. administrative controls,
  - 3.7.3. personal protective equipment.

#### 4. Qualitative Risk (QR)

- 4.1. The Risk-Based Engineering Evaluation shall, as a first step, use a Qualitative Risk based approach to evaluate adequacy of pressure system integrity.
- 4.2. The qualitative risk evaluation shall identify:
  - 4.2.1. the system(s)
  - 4.2.2. the hazard(s) (deficiency)
  - 4.2.3. the probability assessment
  - 4.2.4. the consequence of failure evaluation
  - 4.2.5. the subsequent QR number (see Table E-3)
- 4.3. The Qualitative Risk based evaluation shall be based on probability and consequence of a single point system failure for each deficiency observed.
- 4.4. Probability factors to be considered include the following:
  - 4.4.1. Corrosion potential (crevice corrosion, general, galvanic, etc...)
  - 4.4.2. Materials of Construction (composite, plastic, steel, brass, etc...)
  - 4.4.3. Material compatibility (lubricants, seals, and general materials)
  - 4.4.4. Oxygen Systems
  - 4.4.5. Erosion potential
  - 4.4.6. Fatigue cycles (cycle life)
    - 4.4.6.1. Low –cycle fatigue (where significant plastic straining occurs).
    - 4.4.6.2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region)
  - 4.4.7. Size (contained energy)
  - 4.4.8. Human Error
  - 4.4.9. Operating History
  - 4.4.10. Damage Mechanisms
  - 4.4.11. Operation in Creep range
  - 4.4.12. Stress intensification factors; for example, cracks or acute angles in pressure boundaries
  - 4.4.13. Available Documentation
    - 4.4.13.1. Welding
    - 4.4.13.2. Code Pressure Test
  - 4.4.14. Documentation of ASME Code fabrication
  - 4.4.15. MAWP and Design Pressure as used in code calculations
  - 4.4.16. Design Temperature
  - 4.4.17. Corrosion allowance determination
  - 4.4.18. Code required calculations (as applicable)
  - 4.4.19. Minimum wall thickness
  - 4.4.20. Nozzle reinforcement
  - 4.4.21. Thermal load calculations
  - 4.4.22. Seismic calculations
  - 4.4.23. Support structure
  - 4.4.24. Wind loading
  - 4.4.25. Piping flexibility analysis
  - 4.4.26. Cyclic loading calculations
  - 4.4.27. Other static loadings (static fluid head)
  - 4.4.28. Other dynamic loadings
  - 4.4.29. Historical Operational Documentation
    - 4.4.29.1. Corrosion rate (mils/year) (Used to determine inspection interval)
    - 4.4.29.2. Locations and dates of thickness measurements
    - 4.4.29.3. Year of construction
    - 4.4.29.4. Date of original installation
    - 4.4.29.5. Date of first use

- 4.4.29.6. Out of service periods (Used to determine inspection interval)
  - 4.4.29.7. Discrepancy conditions
  - 4.4.29.8. A comprehensive chronological record of maintenance history
  - 4.4.29.9. History of repair – objective evidence required for ASME code stamped items.
  - 4.4.29.10. History of alterations – objective evidence required for ASME code stamped items.
  - 4.4.29.11. Historical inspections records of NDE
  - 4.4.29.12. Applicable variances/waivers.
  - 4.4.29.13. Fabrication documentation
  - 4.4.29.14. Leak test records
  - 4.4.29.15. Maintenance sheet
  - 4.4.29.16. Daily logs
  - 4.4.29.17. Boiler Records – Water treatment, maintenance, and boiler appurtenances
  - 4.4.29.18. Engineering evaluations as required by this Chapter
- 4.5. Consequences of failure to be considered include the following safety and health issues:
- 4.5.1. Chemical toxicity
  - 4.5.2. Physical Hazards (e.g., projectiles)
  - 4.5.3. Flammability
  - 4.5.4. Radioactivity
  - 4.5.5. Asphyxiation hazards
  - 4.5.6. Volume
  - 4.5.7. Failure Mode
    - 4.5.7.1. Brittle fracture failure mode
    - 4.5.7.2. Leak before burst failure mode
  - 4.5.8. Inhabited areas
  - 4.5.9. Shielding (glove box, fume hood, test cell)
  - 4.5.10. Other issues may be considered as well include
    - 4.5.10.1. Mission criticality
    - 4.5.10.2. Economic impact
    - 4.5.10.3. Schedule
    - 4.5.10.4. Environmental impact
- 4.6. Qualitative Risk evaluation shall be performed by a qualified engineer with the necessary background, experience, and expertise to provide accurate assessments.
- 4.7. Qualitative Risk shall be controlled to QR number of 4 or higher per Table E-3.

## 5. Hazard Mitigation

- 5.1. Based on the results of the probability evaluation, a probability bin is selected as defined in Table E-1, Failure Probability.
- 5.2. Based on the results of the consequence evaluation, a consequence bin is selected as defined in Table E-2, Consequence of Failure.
- 5.3. Enter Table E-3, Qualitative Risk Evaluation, and locate the QR number which corresponds to the intersection of the probability bin (A through E) and consequence bin (I through V).
- 5.4. If the QR number is less than 4, than the Risk-Based Engineering Evaluation shall provide a methodology to reduce risk, through correction of deficiencies or introduction of additional controls.
- 5.5. If the QR number is less than 4, refer to Table E-4, QR Action Matrix, to determine the approved actions to correct the issues.

This appendix is based on API RP 580-2009 Risk-Based Inspection methodology.

Table E-1 Failure Probability

Level	Description	Qualitative
A (Frequent)	Frequent	Likely to occur immediately
B (Probable)	Probable	Probably will occur in time
C (Occasional)	Occasional	May occur in time
D (Remote)	Remote	Unlikely to occur
E (Improbable)	Improbable	Improbable to occur

Table E-2 Consequence of Failure

Category	Description	Examples
I	Major	Fatalities, and/or major long-term environmental impact
II	Serious	Serious injuries, and/or significant environmental impact
III	Significant	Minor injuries, and/or short-term environmental impact
IV	Minor	First aid injuries only, and/or minimal environmental impact
V	Insignificant	No significant consequence

Table E-3 Qualitative Risk (QR) Determination

C o n s e q u e n c e			Probability				
			A	B	C	D	E
			Frequent	Probable	Occasional	Remote	Improbable
I	Major	1	1	1	2	3	
II	Serious	1	1	2	3	4	
III	Significant	1	2	3	4	5	
IV	Minor	2	3	4	5	6	
V	Insignificant	3	4	5	6	7	

**Table E-4**  
**Action Matrix for Legacy Pressure System Deficiencies**

Item	Deficiency	QR 1	QR 2	QR 3
1.	Vessel rating; rating unknown (unknown design pressure or MAWP)	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP, or 3) Perform minimum wall calculation, perform field verification of minimum wall, and perform code-compliant pressure test
2.	Piping component rating; rating unknown (unknown design pressure or MAWP)	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP	1) Replace item with rated item, or 2) Perform code-compliant calculations to establish MAWP, or 3) In cases where published manufacturer's literature provides a maximum operating pressure: determine appropriate system design pressure, confirm that manufacturer's maximum pressure condition is greater than system design pressure, and perform code-compliant pressure test
3.	Missing or out of date system schematic	Create or update sketch or drawing in accordance with Section 11.E of this Chapter	Create or update sketch or drawing in accordance with Section 11.E of this Chapter	Create or update sketch or drawing in accordance with Section 11.E of this Chapter
4.	Materials of construction not suitable for service	Replace item with correct material	Replace item with correct material	1) Replace item with correct material, or 2) Provide shielding, or 3) Control personnel exposure to hazard

Item	Deficiency	QR 1	QR 2	QR 3
5.	Code stamped vessel code data report not available (U1, U1A, P1, etc)	1) Obtain manufacturer’s shop drawing and verify that vessel has not been modified  2) If manufacturer’s shop drawing is not available, obtain written statement from system owner that vessel has not been modified  3) If vessel has been modified, perform code calculations to confirm that the vessel is still code compliant  4) Replace vessel	1) Obtain manufacturer’s shop drawing and verify that vessel has not been modified  2) If manufacturer’s shop drawing is not available, obtain written statement from system owner that vessel has not been modified  3) If vessel has been modified, perform code calculations to confirm that the vessel is still code compliant  4) Replace vessel	1) Obtain manufacturer’s shop drawing and verify that vessel has not been modified  2) If manufacturer’s shop drawing is not available, obtain written statement from system owner that vessel has not been modified  3) If vessel has been modified, perform code calculations to confirm that the vessel is still code compliant  4) Replace vessel
6.	Non-ASME code stamped vessel design and fabrication documentation not in compliance with ASME Section VIII			
6.1	Code compliant design calculations, including: minimum wall thickness, corrosion allowance, weld efficiency rating, support structure loading, nozzle calculations	1) Perform code-compliant calculations (require review by Professional Engineer), or  2) Replace with code-stamped vessel	1) Perform code-compliant calculations (require review by Professional Engineer), or  2) Replace with code-stamped vessel	1) Perform code-compliant calculations (require review by Professional Engineer), or  2) Replace with code-stamped vessel , or  3) Provide shielding or control personnel exposure to vessel when pressurized

Item	Deficiency	QR 1	QR 2	QR 3
6.2	Pressure Test Report	1) Perform code pressure test	1) Perform code pressure test	1) Perform in-service leak test, or 2) Provide shielding or control personnel exposure when pressurized
6.3	Modification or alteration calculations	1) Perform code compliant calculations to verify proper modification or alteration, or 2) Replace with code-stamped vessel	1) Perform code compliant calculations to verify proper modification or alteration, or 2) Replace with code-stamped vessel	1) Perform code compliant calculations to verify proper modification or alteration, or 2) Replace with code-stamped vessel, or 3) Provide shielding or control personnel exposure when pressurized
6.4	Non-Destructive Evaluation (NDE) data reports	1) Perform NDE as required by code	1) Perform NDE as required by code, or 2) Perform code pressure test	1) Perform NDE as required by code, or 2) Perform in-service leak test, or 3) Provide shielding or control personnel exposure to system when pressurized
7.	Piping System design and fabrication documentation not in compliance with applicable B31 piping code			

Item	Deficiency	QR 1	QR 2	QR 3
7.1	Piping System Code required calculations, for example, in B31.3: 301.10 cyclic effects, 304 pressure design, 304.3.5 external forces, thermal expansion and contraction, dead and live loads, 319 flexibility analysis, 319.2.1(c) wind loading, and seismic loading; see specific code for additional detail	1) Perform code-compliant calculations	1) Perform code-compliant calculations	1) Perform code-compliant calculations 2) Provide shielding or control personnel exposure to system when pressurized
7.2	Pressure Test Report	1) Perform code pressure test	1) Perform code pressure test	1) Perform in-service leak test 2) Provide shielding or control personnel exposure to system when pressurized
7.3	Piping System Non-Destructive Evaluation (NDE) data reports	1) Perform NDE as required by code	1) Perform NDE as required by code, or 2) Perform code pressure test	1) Perform NDE as required by code, or 2) Perform in-service leak test, or 3) Provide shielding or control personnel exposure to system when pressurized
8.	Other	Action reviewed and approved by CPSO	Action reviewed and approved by CPSO	Action reviewed and approved by CPSO

**F. Appendix F – Category M Fluids**

Category M at LANL per ASME B31.3 Process Piping<sup>94</sup>. Also defines lethal substances for LANL per B&PV Code Section VIII<sup>95</sup>. No designation indicates non-toxic/non-lethal.

ID is not necessarily the Opsys system ID per ESM Chapter 1 Section 210.

<sup>94</sup> See ASME B31.3 paragraph 300.2 Definitions for “Fluid Service”

<sup>95</sup> See ASME B&PV Code Section VIII UW-2 paragraph (a) and footnote 1

ID	Media	Cat M/Lethal
AC	Acetylene	
AW	Acid Waste	<b>YES</b> (for concentrated solutions)
AG	Argon	
AK	HCFC – 225G (cleaning fluid)	
AM	Ammonia	
AAM	Anhydrous Ammonia	<b>Yes</b>
AR	Air	
AZ	Aerozine 50 Fuel	<b>YES</b>
AN	Aluminum Nitrate	
BA	Breathing Air	
BH	Biological Hazard (deadly)	<b>YES</b>
BF	Boiler Feed Water	
CG	Calibration Gas	Depends on the test gas
CS	CAM Sample Air	
CW	Caustic Waste	
CR	Central Circulating Hot Water Return	
CS	Central Circulating Hot Water Supply	
WR	Central Chilled Water Return	
WS	Central Chilled Water Supply	
CI	Chemical Injection (Water Systems)	
CL	Chlorine	<b>YES</b>
CL	Chlorine Gas	<b>YES</b>
CO2	Carbon Dioxide	
CO	Carbon Monoxide	
CF4	Carbon Tetra fluoride	
CW	Chilled Water	
CA	Compressed Air	
CD	Condensate Pump Discharge	
DE	Diesel	

ID	Media	Cat M/Lethal
DI	Deionized Water	
DI	Deionized Water Return	
DI	Deionized Water Supply	
DW	Distilled Water	
DR	Drain	
DTR	Dri-Train Return	
DTS	Dri-Train Supply	
DU	Deuterium	
HDV	House Dry Vacuum	
PDV	Process Dry Vacuum	
EG	Ethylene Glycol	
FS	Fire Suppression	
FSA	Fixed-Head Sample Air	
F	Fluorine Gas	<b>YES</b>
FE	HFE – 7100 (cleaning fluid)	
FR	Freon (R12) dichlorodifluoromethane	
FU	Monomethylhydrazine (MMH) Fuel	<b>YES</b>
FX	Fire Protection Water	
GH	Gaseous Hydrogen	
GN	Gaseous Nitrogen	
GO	Gaseous Oxygen	
GS	Gasoline	
HA	Halon Fire Suppression	
HWR	Heating Water Return	
HWS	Heating Water Supply	
HPS	High Pressure Steam (above 15 psig)	
HIB	hydroxyisobutyric acid	
HIB	hydroxyisobutyric acid	
HCl	Hydrochloric Acid	<b>YES</b>
HC	Hydrocarbon Liquid	
HD	Hydraulic Fluid	
HE	Gaseous Helium	
HF	Hydrofluoric Acid	<b>YES</b>
HG	Mercury	<b>YES</b>
HL	Liquid Helium	
HCL	Hydrogen Chloride gas	<b>YES</b>

Section I

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ID	Media	Cat M/Lethal
HF	Hydrogen Fluoride	<b>YES</b>
HP	Hydrogen Peroxide (H <sub>2</sub> O <sub>2</sub> )	
HR	Hydrofluoroether	
HW	Hot Water	
HY	Hydrazine Fuel	<b>YES</b>
HZ	Hazardous Waste	Depends on the makeup of the waste
IP	Isopropyl Alcohol	
IW	Industrial Waste	
IW	Industrial Water	
IA	Instrument Air	
KE	Kerosene	
KR	Krypton	
LWR	Limited-Volume Circulating Chilled Water Return	
LWS	Limited-Volume Circulating Chilled Water Supply	
LA	Liquid Air	
LH	Liquid Hydrogen	
LN	Liquid Nitrogen	
LO	Liquid Oxygen	
LP	Propane, Butane	
LX	Lexsol	
LPC	Low-Pressure Condensate (15 psig or less)	
LPG	Low-Pressure Natural Gas (Less than 14 in. w.c.)	
LPS	Low-Pressure Steam (15 psig or less)	
HG	Mercury	
MA	Methyl Alcohol	
ME	Methane	
MF	MF Freon	
NA	Sodium Hydroxide (NaOH)	<b>YES</b> (for concentrated solutions)
NG	Natural Gas	
NWR	Negative-Pressure Circulating Chilled Water Return	
NWS	Negative-Pressure Circulating Chilled Water Supply	
NE	Neon	
NO	Nitric Acid	<b>YES</b> (for

ID	Media	Cat M/Lethal
		concentrated solutions)
OL	Oil	
OX	Oxidizer, Dinitrogen Tetroxide (N <sub>2</sub> O <sub>4</sub> )	<b>YES</b>
P10	P10 gas mix	
PWR	Positive-Pressure Circulating Chilled Water Return	
PWS	Positive-Pressure Circulating Chilled Water Supply	
PW	Potable Water	
PHW	Potable Hot Water Return	
KOH	Potassium Hydroxide	
PCA	Process Compressed Air	
PWR	Process Cooling Water Return	
PWS	Process Cooling Water Supply	
RLW	Radioactive Liquid Waste	
RL	Refrigerant Liquid	
RS	Refrigerant Suction	
RG	Regeneration Gas	
SC	Sodium Carbonate	
SC	Sodium Citrate	
NAOH	Sodium Hydroxide	
SS	Sanitary Sewer	
SP	Sump Pump Discharge	
SF	Sulfur Hexafluoride (SF <sub>6</sub> )	
ST	Steam	
TF	TF Freon	
TG	Test Gas (Special types, mixes, etc.)	Depends on the test gas
TWD	Tower Water Drain	
TWR	Tower Water Return	
TWS	Tower Water Supply	
TW	Treated Water	
T3	Tritium	
UD	Unsymmetrical Dimethyl Hydrazine (UDMH) Fuel	<b>YES</b>
VA	Vacuum	
VH	Vent Header (to Zone 1)	
WV	Wet Vacuum	
WA	Water	
Z1	Zone 1	