Table of Contents

1.0 GENERAL 2
A. Introduction and Applicability 2
B. Exempt 4
C. Excluded 5
D. Chapter Overview 5
E. Alternate Method/Variance 5
2.0 Qualification Requirements 6
A. Pressure Safety Officers (PSO) 6
B. Pressure System Designers 6
C. Owner's Inspectors 7
D. Examiners 8
E. Pressure Safety Committee 8
3.0 Attachments 9
Attachment GEN-1 Definitions and Acronyms 9
Attachment GEN-2 Exclusions from Program 9
Attachment GEN-3 OSHA Requirements for Pressure Systems 9

RECORD OF REVISIONS (GEN)

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue. Section I rev. 3 separated into alpha-named sections. Incorporation of lessons learned, variances, and clarifications in material remaining in GEN. NA-LA concurred with chapter/changes (EMRef-69)	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

HISTORY OF CHAPTER (Chapter 17 Section I)

0	3-10-09	Initial issue.	Charles DuPre, *ES-DE*	Kirk Christensen, *CENG-OFF*
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, *ES-DE*	Gary Read, *CENG-OFF*
2	8-2-09	Clarified 9.0.B, C, and G and 9.0.I regarding	Charles DuPre,	Gary Read,

		handling of deficiencies.	ES-DE	CENG-OFF
3	5-11-10	General revision to incorporate approved clarifications, alternate methods, and lessons learned. LASO concurred with changes (Vozella email EMRef-62).	Charles DuPre, ES-DE	Larry Goen, CENG-OFF

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

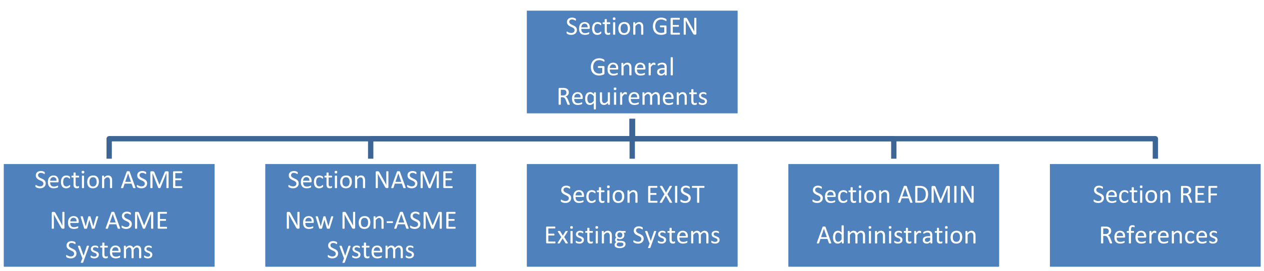
This document is online at http://engstandards.lanl.gov

1.0 GENERAL

A. Introduction and Applicability

1. Engineering Standards Manual Chapter 17 *Pressure Safety* contains the requirements for management of pressure systems to ensure that both new and existing systems are compliant with applicable 10CFR851 Appendix A, Part 4 requirements (*reproduced as REF-1 of this chapter*).[1]

2. The structure of this chapter was changed in 2014 to clearly group requirements for new ASME construction, new non-ASME construction, existing systems, and the program's administrative requirements (including maintenance). References are also included:



Note: In the event of a conflict between this Chapter and guidance or referenced documentation, this document shall take precedence.

[1] At time of writing, the Engineering Services Division Leader is the safety management program owner for pressure safety

3. This Section also has attachments that apply to all sections of the pressure safety program that include the following:

   - Definitions and Acronyms
   - Exclusions from the Program
   - OSHA Requirements for all Pressure Systems

4. This chapter establishes the design, review, inspection, fabrication, testing, and pressure program management requirements for pressure systems in use at LANL. Operational safety requirements can be found in LANL Procedure P101-34, *Pressure Safety*; however, such safety requirements must be taken into account when designing and working with pressure systems.

   a. 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.

5. 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[2] 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.

   a. For example, use B31.1 for site steam distribution, B31.5 for refrigeration piping, and B31.9 for building services where the LANL-adopted plumbing code[3] does not apply.

   b. The UPC stops applying when chemicals are added to the water (e.g. boiler treatment) or after the water is run through a process (e.g., DI water).

   c. A summary listing of the applicable ASME B31 and DOT codes is presented in Chapter 17 document ASME-1, *Code and Regulation Application (Scope Summaries).*

   d. Attachments to NASME titled Equivalency Evaluations for New Non-ASME Pressure systems (1-a, 1-b, etc.) contain engineering equivalencies for piping not associated with pressure vessels, boilers, air receivers, or supporting piping systems (see GEN-1 definition of supporting piping systems).

6. Pressure and vacuum systems (including but not limited to facility, utility, environmental, R&D, and programmatic) are subject to the requirements of this program except as noted below:

   a. Vacuum systems that do not have the potential for catastrophic failure due to backfill pressurization or internal pressure generation.
   b. Others as noted under Exempt below.

---

[2] For the applicability of ASME B31.3 see B31.3 Para 300.1.1 regarding the content and coverage.
[3] Plumbing code adopted by ESM Chapter 16, IBC-GEN Att A. (*e.g., IAPMO UPC)*

7. New pressure systems in preliminary design as of March 10, 2009 (original issuance of this Chapter) must be certified according to this Chapter prior to use.

8. 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).[4]

   a. In addition, existing systems are subject to the certification and preventive maintenance requirements herein, as well as being expected to maintain (but generally not recreate) required documentation.[5]

9. Documentation, including forms, generated by this program must be considered records, and must be managed per LANL P1020, P1020-1, and P1020-2 located here.

10. ASME Boiler and Pressure Vessel Codes and the B31 series of piping codes are designed to be so that when applied personnel close proximity to the finished pressure system are exposed to a low risk level.

11. Mobile and portable pressure systems are also included in this program. These can include tube trailers, vehicle-mounted vessels, and skid-mounted vessels.

12. 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.

B. Exempt

1. Pressure systems with a design pressure [or existing system with MAWP below 15 psig provided the fluid handled is nonflammable, nontoxic, and not damaging to human tissues as defined in 300.2, and its design temperature is from −29°C (−20°F) through 186°C (366°F)] are exempt from the majority of requirements of this chapter provided there is documented adequate relief protection.

2. The first relief device of an exempt system is NOT exempt and must be entered into CMMS or other approved data repository for tracking.

3. Applicable requirements are inventory and System Identification Tag with "Exempt" printed in the sticker area; Pressure System Certification Status Form (*Section ADMIN-1-1 Form 1*), an evaluation showing the system cannot be pressurized to greater than 15 psig (without relief device activation), and inclusion of the relief device into the maintenance tracking system. The regulator and the relief device must be close-coupled with no intervening stop valves. A copy of a simplified system sketch and the documentation showing the system is adequately protected against overpressure shall be maintained as records.

[4] ESM Ch 1 Section Z10 normally grandfathers projects underway for new requirements; however, 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.
[5] Unlike many ESM chapters, this is a complete program and not only for new installations.

C. Excluded

1. Excluded systems are those pressure system categories that were not inventoried during the pressure safety project. See Attachment GEN-2

D. Chapter Overview

1. This Chapter addresses the process by which new pressure systems are made or existing systems are modified and both are 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.[6]

2. 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.

3. The CPSO may perform or participate in an annual assessment to evaluate institutional compliance with requirements of the Pressure Safety Program as defined in this chapter.

E. Alternate Method/Variance

1. Request for variance from compliance with this chapter, or alternate methods and clarifications, must be submitted to the CPSO, for review and approval processing.

2. 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.

   c. Systems where installation of pressure relief devices is impossible or unnecessary (such variances must be reviewed for applicability against ASME Code Case 2211 and ASME Section VIII, Division 1, Part UG-140).

3. Approval is requested per ESM Chapter 1 Section Z10. (*Owner submits a Conduct of Engineering Request for Variance or Alternate Method, LANL Form 2137)*

4. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.

5. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10 CFR 851.

[6] 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.

6. 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 Engineering websites.

   b. Variances cannot conflict with a Safety Basis.

7. Extension of variances will not be granted without justification by the Requestor, the Design Authority Representative (if assigned), and the LANL Owning Manager (FOD or RAD); see ESM Chapter 1 Section Z10 and Form 2137. Extensions will be processed as a revision to the original request. Documentation provided with the extension request will be current and support the justification request.

8. Variances to code are not allowed for new ASME code-compliant pressure construction.

9. Alternative Methods are used to document alternatives allowed by code.

2.0 QUALIFICATION REQUIREMENTS

A. Pressure Safety Officers (PSO)

LANL Pressure Safety Officers (PSOs) shall be trained and qualified in accordance with requirements stipulated in Qualification Standard QS-CT-LANL-QS-319 or its successor.

NOTE: The PSOs qualification standard has different duty areas of responsibilities and the PSO may or may not be qualified depending on the type of work being performed. The current official qualifications are maintained in UTrain, but quick reference is located on the Pressure Protection Program page with the title “Pressure Safety: Officer Qualification Status.”

PSO Duty Area	ASME B31 Code	Training Plan (TP)
A	None	11957
B	B31.3	11958
C	B31.9	11959
D	B31.1	11960
E	B31.8	11961

B. Pressure System Designers[7]

1. 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

[7] ASME B31.3 Article 301.1 Qualifications of the Designer

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 of 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 of experience in the design of related pressure piping.

d. Fifteen (15) years of experience in the design of related pressure piping.

e. 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.

C. Owner's Inspectors[8]

1. The owner's Inspector shall have not less than 10 years of experience in the design, fabrication, or inspection of industrial pressure piping each 20% of satisfactorily completed work toward an engineering degree recognized by the Accreditation Board for Engineering and Technology (Three Park Avenue, New York, NY) shall be considered equivalent to 1 year of experience, up to 5 years total. (B31.3 340.21-340.4)

2. It is the owner's responsibility, exercised through the owner's Inspector, to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the code and of the engineering design. (B31.3 340.2)

3. The owner's Inspector and the Inspector's delegates shall have access to any place where work concerned with the piping installation is being performed. This includes manufacture, fabrication, heat treatment, assembly, erection, examination, and testing of the piping. They shall have the right to audit any examination, to inspect the piping using any examination method specified by the engineering design, and to review all certifications and records necessary to satisfy the owner's responsibility; to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the code and of the engineering design. (B31.3 340.2 and 340.3)

4. The Owner's Inspection program is implemented by CM-CE (Project Field Engineering).

5. If personnel qualified as Pressure Safety Officers have the code-required experience, they may be granted the authority of the Owner's Inspector or the Owner's Inspector

[8] ASME B31.3 Article 340.4 Qualifications of the Owner's Inspector

Designee by Construction Management per the duty areas shown above under PSO qualification.

a. PSOs acting for the Owner's Inspector must follow the requirements of the Owner's Inspector program including utilization of the appropriate check lists and the designated mandatory inspection points.

NOTE: The Owner Inspector qualification standard has different duty areas of responsibilities and the PSO may or may not be qualified depending on the type of work being performed. The current official qualifications are maintained in UTrain, but quick reference is located on the Construction Management site with the title "LANL Owner's Inspectors."

D. Examiners

1. Examiners shall have training and experience commensurate with the needs of the specified examinations. (B31.3 342.1)

2. The employer shall certify records of the examiners employed, showing dates and results of personnel qualifications, and shall maintain them and make them available to the Inspector. (B31.3 342.1)

3. Examiners are assigned by the Responsible Line Manager (RLM) in accordance with LANL Policy P330-8, paragraph 3.6. This procedure applies LANL wide, and the document is for Inspection and Tests required for acceptance.

4. An example of required code Examination is for pneumatically tested, pressure systems an assembly tubing components for a piping systems meeting the scope of B31.3 would need examination in accordance with B31.3 341.4.1(a)(4) "When pneumatic testing is to be performed, all threaded, bolted, and other mechanical joints shall be examined".

5. The examiner shall provide the Inspector with a certification that all the quality control requirements of the code and of the engineering design have been carried out. (Normal fluid 341.4.1(c)).

6. ESM Chapter 13 Volume 6, *Welding Inspection and General NDE*, contains LANL NDE qualifications.

E. Pressure Safety Committee

1. The Pressure Safety Committee (also known 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.

2. 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.

3.0 ATTACHMENTS

Attachment GEN-1 Definitions and Acronyms

Attachment GEN-2 Exclusions from Program

Attachment GEN-3 OSHA Requirements for Pressure Systems

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.

Asset Suite – Name of LANL's Computerized Maintenance and Management System (CMMS) Ventyx software package that includes the Master Equipment List. Required by this pressure safety program for tracking facility and utility relief valve testing, vessel inspections, and flex hose inspections. Formerly PassPort.

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].

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 Asset Suite).

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, UPC), or the lack of documentation demonstrating code-equivalent fabrication.

Code of Record – The codes and standards (by year) used to perform the design and construction are considered the code of record (COR). (see ESM Chapter 1 Section Z10 - General Requirements for all Disciplines/Chapters)

Components – The set of items within a piping system that are joined together to 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 that make up a process (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 Sections 200 and 230.

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 (e.g., CO_2, 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 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.

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). Basically, the final design temperature and design pressure are that combination that gives the most critical result in terms of stresses and forces. It is commonly called the concurrent temperature and pressure that requires the thickest-wall pipe or highest rating of the components.

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

Engineering calculation – Formal document performed in accordance with AP-341-605 (or equivalent for R&D) 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 (STD-342-100) mandated by P342.

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.

Exempt System – A system that by virtue of its design features is not required to meet code; the non-toxic material is being used at 75 F maximum and less than 15 psig with no possibility of over pressure.

Existing pressure system - Existing systems are all installed pressure systems (post construction) of which Legacy Pressure Systems are a subset.

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 or institution, not directly by the program it supports. Normally either a utility proper or found in utility rooms that provide building services (e.g., building heating boilers, instrument air system, etc.). See programmatic pressure system for that definition.

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:[1]

- **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 quantify 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).[2] Steam and hot water systems above 180 °F.[3]
- **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.

Note: FS Categories are a designation of the most stringent requirements within a given system. They are not necessarily the appropriate requirements for every item within a system. Appropriate designation of the subsystems within a system is allowed with concurrence of the PSO. For example, an ambient temperature, B31.3 high-pressure nitrogen gas system at 10,000 psig is an FS1 system. If a regulator is used to drop the pressure to 1,500 psig (less than the rating requirement for a high pressure system), and there is appropriately sized pressure relief protection, the items of this

[1] Similarly, a graded approach can be found in API 570 "Piping Inspection Code." FS Categories are 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 system contains fluids that meet the ASME definition of Category M). Where consensus cannot be reached, the CPSO makes the final determination of fluid service category.

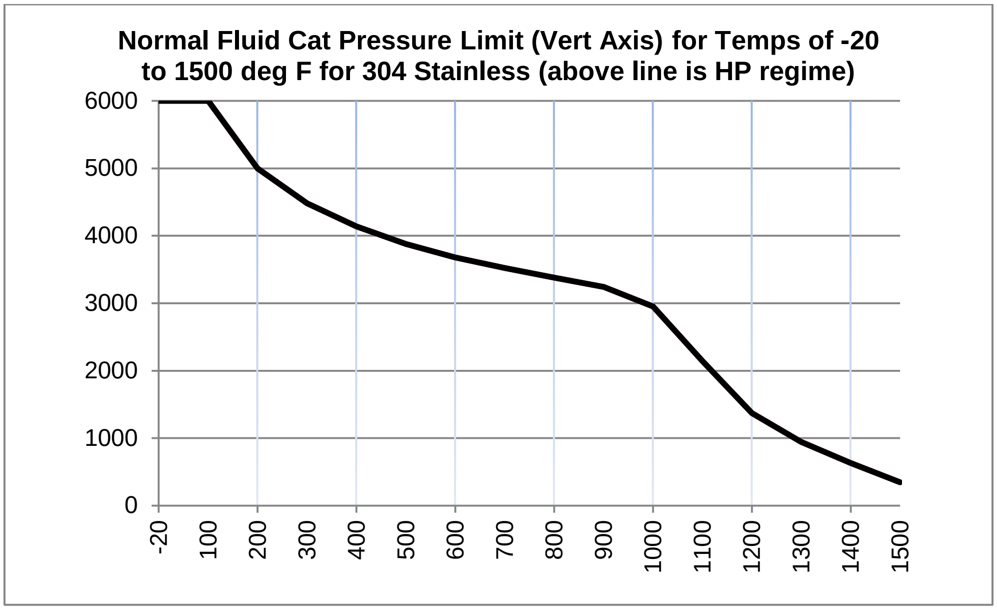
[2] "Equate to" appears here (and for FS3) so that piping subject to B31 codes other than B31.3 can use the FS definitions which are largely based on B31.3 definitions.

[3] Because steam is damaging to human tissue, LANL chooses to treat as FS2 for deficiency resolution reasons.

subsystem could be classified as FS2. Grace periods of ESM Chapter 17 for FS2 would then be applicable to those items. However, the overall designation of FS1 would remain for the system.

Good operating history - is defined as service history of an existing pressure system, where a record of successful service may be created by the System Owner confirming that no failures have occurred in the system pressure boundary, that no pressure or temperature transients have occurred which exceeded the system design basis, and that personnel have not been harmed while operating or in close proximity to the system.

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 depends on material type at temperature. The chart below is only one example using B16.5 table data to illustrate the function of temperature versus pressure for Type 304 stainless (for which “high pressure” could be as low as 345 psig at 1,500 degrees F). See also Chapter IX of ASME B31.3.



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).

IRM – Information Resource Management – the Pressure Safety Program utilizes a dedicated server, Pressure System Certification System. Contact the CPSO for access to the database.

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, hydro-pneumatic leak test, pneumatic leak test, initial service leak test, and sensitive leak test. These tests are described in ASME B31.3, Section 345.

Legacy pressure system - Systems that were operational as of March 10, 2009 (when ESM Chapter 17 revision 0 was issued) are considered legacy pressure systems.

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 – Term used by the pressure program only, 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 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 using the code ratings. 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 used 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. At LANL, regulated by ESM Chapter 13 Volume 6.

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.

Owner – While DOE owns the pressure systems at LANL (except vendor owned), day-to-day fulfillment of the codes' Owner role is by the LANL Design Authority (Site Chief Engineer; see also ESM Chapter 1 Section Z10 regarding delegation). Owner's Representative is an agent of the Owner. System Owner is the user (see definition below).

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 (may assume design pressure) using a non-hazardous fluid to ensure the integrity of the pressure system, or component. For example see 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 system – One or more items that fall within the scope of an ASME code.

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 normally both directly paid for and performed by the program, not the facility (see facility pressure system for that definition).

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.

PSCS – Pressure Safety Certification System is the ES-EPD managed database for pressure system certification, pressure safety document repository, and tracking program for programmatic relief valve testing, vessel inspections, and flex hose inspections.

PSO – Pressure Safety Officer. Person familiar with ASME code and who 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.

RAD – Responsible Associate Director

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.[4] 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 a regulated pressure.

SCFM - Standard cubic feet per minute evaluated at 14.7 psia, 58 °F, and 36% relative humidity.

Stop valve – A valve that is installed between the piping or component being protected and its protective device (e.g., PRV) or between the protective device and the point of discharge. Although allowed by the

[4] ASME Section VIII, Division 1, 2007 edition, footnote 61

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.[5]

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.).

Supporting piping systems – Term shall be considered any and or all the piping necessary for the function of the process or system for all pressure vessels, boilers, and air receivers. Piping that is attached in excess of that required for the process or system operation is not "supporting piping". For LANL, new system boundary rules are defined by ESM Chapter 1, Section 220 (existing may not always conform) and Chapter 1, Section 210, Attachment A lists existing systems and general boundaries. In practical applications to separate "supporting piping" from non-supporting piping, a unique pressure safety system identification number in accordance with ESM Chapter 17 will be used to identify piping that is considered to be non-supporting piping.

System – For this chapter, a **c**ombination 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 during 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. It 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.

[5] See ASME B31.3 paragraph 322.6.1

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.

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Formerly Subsection 7.0 of Section I rev. 3.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Systems Excluded from Pressure Safety Program

Note: Excluded-from-walkdown column refers to inventory effort circa 1999-2001, not entire program.

Type of system	Excluded from walk-downs but included in program	Excluded from pressure safety program
Domestic potable water systems designed per Universal Plumbing Code (UPC)		✓
Chilled water systems (except radiation contaminated)	✓	
Systems under NFPA Fire suppression systems covered by NFPA Codes and Standards [e.g., NFPA 13 (sprinklers) and NFPA 14 (standpipes)]. Natural gas systems from the service meter to the appliance meeting NFPA requirements.		✓
Fire extinguishers covered by 29 CFR 1910 and NFPA 10		✓
Control, instrument, and shop air or inert gas piping systems with MAWP not to exceed 150 psig and line sizes not to exceed NPS 3/8”	✓	
Gloveboxes *(design pressure less than 15 psig)*		✓
Fuel storage pressure systems supplied with licensed motorized vehicles and meeting applicable DOT regulatory requirements		✓
Temporary non-LANL owned construction or maintenance related systems		✓
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		✓

Type of system	Excluded from walk-downs but included in program	Excluded from pressure safety program
applicable American Petroleum Institute (API) or Underwriters Laboratories Incorporated (UL) standards.		
Self-contained pressure eye wash systems, provided over pressure protection devices are periodically tested or replaced in accordance with manufacturer's recommendation		✓
DOT specification containers periodically retested and re-qualified strictly in accordance with 49CFR180, provided that the owner's OSHA inspection requirements of 29 CFR 1910.101 are met. (e.g. DOT gas cylinders)		✓
Natural gas distribution systems covered by DOT or 49CFR192 or other monitoring/maintenance regulation	✓	
Facility water and sewer systems such as drinking fountains, faucets, garden hoses lawn sprinkler systems, and the like that are not governed by ASME BPV or B31 codes[1]		✓
Packaged refrigeration (to include HVAC and refrigerators) units bought commercially, off-the-shelf, without modification not subject to B31.5		✓
Facility water wells, water tanks, and water distribution piping not subject to B31 codes. [2]		✓
Welding, brazing, or soldering equipment covered by other standards, for example CGA or 29CFR1910.		✓
Commercially available alternative fuel vehicles, such as propane-powered vehicles (49 CFR)		✓
Test Articles, flight weight, flight vehicle pressure systems (e.g. space vehicle propulsion systems and weapon gas systems) Test Articles (as defined in Section I Attachment I-1 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.[3]		✓
Pressure relief protection on commercially-available, off-the-shelf (COTS) systems	✓	
Pressure vessels in COTS systems	✓	

[1] These are governed by the LANL-adopted plumbing code (see ESM Ch 16) or other non-ASME document.
[2] Ibid
[3] All research and development systems that must undergo continuous design changes must be reviewed by the CPSO

1. Excluded Pressure Vessels, Relief Devices, and Systems

A. Excluded Pressure Systems (in addition to table above; in case of conflict, most stringent applies and contact CPSO).

CAUTION: Pressure systems, regardless of whether excluded or in this program, must be designed with appropriately sized pressure relief/vent systems and included in the LANL maintenance process. *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 Chapter 17 Section NASME or equivalent.

   a. 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.

   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) (*Att. REF-1 of this chapter*) which provides an alternate methodology to be invoked in cases when codes are not applicable.

   b. Items that do not pose a risk to personnel and where the risk of damage or system loss is acceptable to the CPSO do not have to comply with the requirements of ESM Chapter 17. To apply this exclusion, two items must be satisfied:

      1) The adequacy of the shielding to protect personnel from the potential failure of the pressurized components must be verified.

      2) Adequate documented controls must be in place to prevent inadvertent pressurization when personnel are not protected by the shielding, for example

         i. Disconnection of all pressure sources

         ii. Double block-and-bleed of all pressurization sources

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. Commercially-available, off-the-shelf (COTS) equipment such as tools, 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.

b. Program does require a temperature and pressure rating of the COTS, and the COTS item will be treated as pressure system component.

c. Relief devices and vessels included as COTS will be included into the LANL maintenance processes. LANL may elect not to perform maintenance on the items until the manufacturer's warranty has expired.

d. 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.

e. 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.

4. 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).

5. 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.[4]

6. 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.[5]

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.

3. Although not specifically included by the requirements of 10 CFR 851, vessels regulated by the Department of Transportation (DOT)[6] 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.

---

[4] 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.

[5] Guidance on vacuum system design can be found in American Vacuum Society publications.

[6] 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 chapter.

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 Ch. 17 Section NASME)

c. DOT vessels must be maintained within inspection interval dates.[7]

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 built to ANSI Z358.1 or ISEA Z358.1

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.

9. Fire extinguishers covered by 29 CFR 1910 and NFPA 10.

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

- 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.
- Pressure containers that rely solely on interlocks to limit the pressure to less than 15 psig[8]
- 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
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.

---

[7] 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).
[8] See Code Case 2211 and ASME Section VIII, Division 1, Part UG-140.

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

OSHA Pressure Safety Requirements

Pressure system shall meet the requirements of 29 CFR 1910.

1. A table that summarizes the applicable code requirements of the CFR is below; see CFR for the complete text and all the requirements.
2. Following the document(s) in the "LANL Applied Code" column satisfies the OSHA requirement for the systems listed.

29CFR1910 Section	Citation	Code Reference	LANL Applied Code	Summary
1910 Subpart H - Hazardous Materials				
1910.101 - Compressed gases (general requirements).	1910.101(a)	CGA C-6 (1968) Standards for Visual Inspection of Compressed Gas Cylinders	CGA C-6	Visual Inspection
	1910.101(a).	CGA C-8 (1962) Standard for Requalification of ICC-3HT Cylinders	CGA C-8	Requalification
	1910.101(b)	CGA P-1	CGA P-1	Cylinder Use
	1910.101(c)	CGA S-1.1 (1963) and 1965 Addenda. Safety Release Device Standards--Cylinders for Compressed Gases	CGA S-1.1	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases
	1910.101(c)	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases	CGA S-1.2	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases
1910.102 - Acetylene.	1910.102(a).	CGA G-1-2003 Acetylene	CGA G-1	Use
1910.103 - Hydrogen.	1910.103(c)(1)(i)(a)	API 620, Fourth Ed. [1970] Including Appendix R, Recommended Rules for Design and Construction of Large Welded Low Pressure Storage Tanks	API 620	Hydrogen containers shall comply with the following: Storage containers shall be designed, constructed, and tested in accordance with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels (1968) or applicable provisions of API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Second Edition (June 1963) and appendix R (April 1965), which is incorporated by reference as specified in Sec. 1910.6.
	1910.103(c)(1)(i)(a)	ASME Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels (1968) or applicable provisions of API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Second Edition (June 1963) and appendix R (April 1965),	ASME Boiler and Pressure Vessel Code Section VIII	Hydrogen containers shall comply with the following: Storage containers shall be designed, constructed, and tested in accordance with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels (1968) or applicable provisions of API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Second

				Edition (June 1963) and appendix R (April 1965), which is incorporated by reference as specified in Sec. 1910.6.
	1910.103(c)(1)(i)(b)		49 CFR	Portable containers shall be designed, constructed and tested in accordance with DOT Specifications and Regulations.
	1910.103(c)(1)(iv)(a)(1)	CGA Pamphlet S-1, Part 3, Safety Relief Device Standards for Compressed Gas Storage Containers	CGA S-1, Part 3	Stationary liquefied hydrogen containers shall be equipped with safety relief devices sized in accordance with CGA Pamphlet S-1, Part 3, Safety Relief Device Standards for Compressed Gas Storage Containers, which is incorporated by reference as specified in Sec. 1910.6
	1910.103(c)(1)(iv)(a)(2)	CGA Pamphlet S-1, Safety Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers.	CGA Pamphlet S-1, Safety Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers.	Portable liquefied hydrogen containers complying with the U.S. Department of Transportation Regulations shall be equipped with safety relief devices as required in the U.S. Department of Transportation Specifications and Regulations. Safety relief devices shall be sized in accordance with the requirements of CGA Pamphlet S-1, Safety Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers.
	1910.103(c)(1)(iv)(d)		ASME B31.12	Safety relief devices shall be provided in piping wherever liquefied hydrogen could be trapped between closures.
	1910.103(c)(1)(v)(b)	Pressure Piping Section 2 - Industrial Gas and Air Piping, ANSI B31.1-1967 with addenda B31.1-1969; Petroleum Refinery Piping ANSI B31.3-1966; Refrigeration Piping ANSI B31.5-1966	ASME B31.12	Gaseous hydrogen piping and tubing (above -20 deg. F.) shall conform to the applicable sections of Pressure Piping Section 2 - Industrial Gas and Air Piping, ANSI B31.1-1967 with addenda B31.1-1969. Design of liquefied hydrogen or cold (-20 deg. F. or below) gas piping shall use Petroleum Refinery Piping ANSI B31.3-1966 or Refrigeration Piping ANSI B31.5-1966 with addenda B31.5a-1968 as a guide, which is incorporated by reference as specified in Sec. 1910.6.
	1910.103(c)(1)(viii)(b)		ASME B31.12	The vaporizer and its piping shall be adequately protected on the hydrogen and heating media sections with safety relief

				devices.
	1910.103(c)(2)(i)(f)		ASME B31.12	If liquefied hydrogen is located in (as specified in Table H-3) a separate building, in a special room, or inside buildings when not in a special room and exposed to other occupancies, containers shall have the safety relief devices vented unobstructed to the outdoors at a minimum elevation of 25 feet above grade to a safe location as required in paragraph (c)(1)(iv)(b) of this section.
	1910.103(c)(1)(iv)(a)(2)	CGA S-1.1 (1963) and 1965 Addenda. Safety Release Device Standards--Cylinders for Compressed Gases	CGA S-1.1	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases
	1910.103(c)(1)(iv)(a)(2)	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases	CGA S-1.2	CGA S-1.2 (1963) Safety Release Device Standards, Cargo and Portable Tanks for Compressed Gases
	1910.103(c)(1)(iv)(a)(2)	CGA S-1.3 (1959) Safety Release Device Standards-Compressed Gas Storage Containers	CGA S-1.3	Gas cylinders, portable tanks, & bulk Oxygen, Anhydrous Ammonia relief
	1910.103(b)(1)(iii)(b)	ANSI B31.1-67 and Addenda B31.1 (1969) Code for Pressure Piping,	B31.12	Code of record
	1910.103(b)(3)(v)(b)	ANSI B31.3-66 Petroleum Refinery Piping,	B31.12	Code of record
	1910.103(b)(3)(v)(b)	ANSI B31.5-66 Addenda B31.5a (1968) Refrigeration Piping	B31.12	Code of record
	1910.103	ASME Boiler and Pressure Vessel Code, § VIII, 1968,	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.104 - Oxygen.	1910.104(b)(6)(iii)	CGA S-1.3 (1959) Safety Release Device Standards-Compressed Gas Storage Containers	CGA S-1.3	Gas cylinders, portable tanks, & bulk Oxygen, Anhydrous Ammonia relief
	1910.104(b)(5)(ii)	ANSI B31.1-67 and Addenda B31.1 (1969) Code for Pressure Piping,	B31.3	Code of record
	1910.104(b)(4)(ii)	ASME Boiler and Pressure Vessel Code, § VIII, 1968,	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
	1910.104(b)(4)(ii) and (b)(5)(iii)	ASME Boiler and Pressure Vessel Code, §VIII, Paragraph UG-84	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.105 - Nitrous oxide.	1910.105	CGA G-8.1	CGA G-8.1	Design
1910.106 -	1910.106(i)(3)(i)	ASME Code for Pressure Vessels, 1968	ASME Boiler and	Code of record

Flammable and combustible liquids.		Ed	Pressure Vessel Code Section VIII	
	1910.106(b)(1)(iv)(b)(2) and (i)(3)(ii)	ASME Boiler and Pressure Vessel Code, § VIII, 1968	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.107 - Spray finishing using flammable and combustible materials.	1910.107	ASME Boiler and Pressure Vessel Code, § VIII, 1968	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.109 - Explosives and blasting agents.	1910.109(i)(1)(ii)(b)	CGA P-3	CGA P-3	Storage
1910.110 - Storage and handling of liquefied petroleum gases.	1910.110(b)(10)(iii) (Table H-26), (d)(2) (Table H-31); (e)(3)(i) (Table H-32), (h)(2) (Table H-34)	ASME Boiler and Pressure Vessel Code, § VIII,	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
	1910.110(b)(11)(i)(b) and (iii)(a)(1)	ASME Boiler and Pressure Vessel Code, § VIII, 1968	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
	1910.110(g)(2)(iii)(b)(2)	ASME Code for Pressure Vessels, 1968 Ed	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
	1910.110(b)(3)(iii)	Code for Unfired Pressure Vessels for Petroleum Liquids and Gases of the API and the ASME, 1951	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.111 - Storage and handling of anhydrous ammonia.	1910.111(d)(1)(ii)	API 620, Fourth Ed. [1970] Including Appendix R, Recommended Rules for Design and Construction of Large Welded Low Pressure Storage Tanks	API 620	Containers with a design pressure exceeding 15 psig shall be constructed in accordance with paragraph (b)(2) of this section, and the materials shall be selected from those listed in API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Fourth Edition, 1970, Tables 2.02, R2.2, R2.2(A), R2.2.1, or R2.3, which are incorporated by reference as specified in § 1910.6.
	1910.111(d)(4)(ii)(b)	CGA S-1.3 (1959) Safety Release Device Standards-Compressed Gas Storage Containers	CGA S-1.3	Gas cylinders, portable tanks, & bulk Oxygen, Anhydrous Ammonia relief

	1910.111(b)(7)(iii)	ANSI B31.5-66 Addenda B31.5a (1968) Refrigeration Piping,	ANSI B31.5	Code of record
	1910.111(b)(2)(vi)	ASME Boiler and Pressure Vessel Code, § VIII	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
	1910.111(b)(2)(i), (ii), and (iv)	ASME Boiler and Pressure Vessel Code, § VIII, 1968	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910 Subpart I - Personal Protective Equipment				
1910.134 - Respiratory Protection.	1910.134(d)(1)	CGA G-7.1		Breathing air specification
1910 Subpart M - Compressed Gas and Compressed Air Equipment				
1910.169 - Air receivers.	1910.169(a)(2)(ii)		ASME Boiler and Pressure Vessel Code Section VIII	All safety valves used shall be constructed, installed, and maintained in accordance with the ASME Boiler and Pressure Vessel Code
	1910.169(b)(3)(iv)			All safety valves shall be tested frequently and at regular intervals to determine whether they are in good operating condition.
	1910.169(a)(2)(i) and (ii)	ASME Boiler and Pressure Vessel Code, § VIII, 1968	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910 Subpart O - Machinery and Machine Guarding				
1910.217 - Mechanical power presses.	1910.217(b)(12)	ASME Code for Pressure Vessels, 1968 Ed	ASME Boiler and Pressure Vessel Code Section VIII	Code of record
1910.218 - Forging machines.	1910.218(d)(4) and (e)(1)(iv)	ANSI B31.1-67 and Addenda B31.1 (1969) Code for Pressure Piping,	B31.3	Code of record
1910 Subpart Q - Welding, Cutting, and Brazing				
1910.252 - General requirements.	1910.252(d)(1)(vi)	API 2201 (1963) Welding or Hot Tapping on Equipment Containing Flammables,	API 2201	Flammable substance lines. The connection, by welding, of branches to pipelines carrying flammable substances shall be performed in

				accordance with Welding or Hot Tapping on Equipment Containing Flammables, API Std. PSD No. 2201-1963, which is incorporated by reference as specified in Sec. 1910.6.
	1910.252(d)(1)(v)	API 1104 (1968) Standard for Welding Pipelines and Related Facilities	API 1104	Construction standards. The welded construction of transmission pipelines shall be conducted in accordance with the Standard for Welding Pipe Lines and Related Facilities, API Std. 1104-1968, which is incorporated by reference as specified in Sec. 1910.6
1910.253 - Oxygen-fuel gas welding and cutting.	1910.253(e)(4)(v) and (5)(iii)	CGA 1957 Standard Hose Connection Standard	CGA 1957	Ox/Ace station termination in union & hose connections
	1910.253(e)(5)(i)	CGA and RMA (Rubber Manufacturer's Association) Specification for Rubber Welding Hose (1958)	CGA and RMA (Rubber Manufacturer's Association) Specification for Rubber Welding Hose (1958)	Oxy-Fuel hoses
	§1910.253(e)(4)(iv) and (6)	CGA 1958 Regulator Connection Standard	CGA 1958 Regulator Connection Standard	Detachable regulator & regulatory requirements
	1910.253(d)(4)(ii)	ANSI A13.1-56 Scheme for the Identification of Piping Systems	ANSI A13.1	Above ground Pipe marking Oxygen-Fuel Gas
	1910.253(d)(1)(i)(A)	ANSI B31.1-67	B31.3	Code of record
1910.254 - Arc welding and cutting.	1910.254(b)(1)			General. Assurance of consideration of safety in design is obtainable by choosing apparatus complying with the Requirements for Electric Arc-Welding Apparatus, NEMA EW-1-1962, National Electrical Manufacturers Association or the Safety Standard for Transformer-Type Arc-Welding Machines, ANSI C33.2-1956, Underwriters' Laboratories, both of which are incorporated by reference as specified in Sec. 1910.6

Conduct of Engineering
Request for Variance or Alternate Method

Assigned by SMPO or SMPOR: ☒ Alternate Method ☐ Variance Tracking number **VAR- 2015-032.0**

1.0 Affected Document(s)

☐ Engineering Processes (e.g., P 341) ☒ Engineering Standards (e.g., P 342) ☐ Engineering Training & Qualification (e.g., P 343) If against P documents themselves, revision:	Subordinate (Functional Series) document if applicable (ESM Chapter, Master Spec, AP, etc.): Document Title/Number: Engineering Standards Manual STD-342-100, Chapter 17, Pressure Safety Revision 0, 9/17/2014
Section/Para: Specified below	

Specific Requirement(s) as Written in the Document(s)

1.1 This form was submitted in accordance with ESM Chapter 17, *Pressure Safety,* Section GEN, Paragraph E

1. Request for variance from compliance with this chapter, or alternate methods and clarifications, must be submitted to the CPSO, for review and approval processing.
2. Approval of an alternate method or variance can occur under the following circumstances:
   b. To permit a long-term operation with a condition that deviates from this document.
3. Approval is requested per ESM Chapter 1 Section Z10. (*Owner submits a Conduct of Engineering Request for Variance or Alternate Method, LANL Form 2137)*
4. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.
5. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10 CFR 851.

1.2 ESM Chapter 17, Section ADMIN-2 Design, Documentation, and Records, Section Q *Piping Components,* item 2:

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.

   a. Records of acceptable components and evaluations shall be kept by the CPSO and made available to all LANL employees.

1.3 ASME B 31.3,

300(c)(3) General Statements:

"(3) Engineering requirements of this Code, while considered necessary and adequate for safe design, generally employ a simplified approach to the subject. A designer capable of applying a more rigorous analysis shall have the latitude to do so; however, the approach must be documented in the engineering design and its validity accepted by the owner. The approach used shall provide details of design, construction, examination, inspection, and testing for the design conditions of para. 301, with calculations consistent with the design criteria of this code."

1.4 ASME B 31.3,

301.2.1 Design Pressure, General:

"(a) The design pressure of each component in a piping system shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service, except as provided in para. 302.2.4."

1.5 ASME B 31.3,

304.7.2 Pressure Design of Other Components, Unlisted Components

"Pressure design of unlisted components to which the rules elsewhere in para. 304 do not apply shall be based on calculations consistent with the design criteria of this Code. These calculations shall be substantiated by one or more of the means stated in paras. 304.7.2(a), (b), (c), and (d), considering applicable dynamic, thermal, and cyclic effects in paras. 301.4 through 301.10, as well as thermal shock. Calculations and documentation showing compliance with paras. 304.7.2(a), (b), (c), or (d), and (e) shall be available for the owner's approval.

(a) Extensive successful service experience under comparable conditions with similarly proportioned components of the same or like material.
(b) Experimental stress analysis, such as described in the BPV Code, Section VIII, Division 2, Annex 5.F.
(c) Proof test in accordance with either ASME B16.9, MSS SP-97, or Section VIII, Division 1, UG-101.
(d) Detailed stress analysis (e.g., finite element method) with results evaluated as described in Section VIII, Division 2, Part 5. The basic allowable stress from Table A-1 shall be used in place of the allowable stress, S, in Division 2 where applicable. At design temperatures in the creep range, additional considerations beyond the scope of Division 2 may be necessary.
(e) For any of the above, the designer may interpolate between sizes, wall thicknesses, and pressure classes, and may determine analogies among related materials."

2.0 Request

Brief descriptive title: Approval for use of Conflat (CF) flanged fittings in pressure systems under certain applications and conditions based upon analysis, testing, and successful service experience.	
NCR required (work has occurred)? ☐ Yes ☒ No	If Yes, NCR Number
TA-BLDG-(Room) and/or Project Affected: Lab-wide	System/Component Affected: New and modified pressure systems as applicable

Background

Applications exist at LANL where piping systems are required to be operated under both vacuum and pressure. Upon extensive research, it has been determined that there are not any reputable manufacturers who can provide components that are rated for vacuum service, and are either ASME B31.3 listed or have a published maximum allowable working (positive) pressure.

Proposal

This Alternate Method is being submitted for approval to use Conflat (CF) flanged fittings as unlisted components in new and modified pressure / vacuum systems under the following applications / conditions based upon analysis, testing, and successful service:

1. Applies only to 1-1/3" and 2-3/4" (outside diameter) stainless steel, rotatable and non-rotatable Conflat flanged fittings with copper gaskets.
2. Applies only to systems that require operation both under vacuum and pressure conditions where listed fittings from a reputable manufacturer that have a published MAWP and are rated for vacuum cannot be obtained.
3. The system design pressure / maximum allowable working pressure will be 50 psig for both 1-1/3" and 2-3/4" fittings.
4. Applies only to applications that are non-cyclic and which are operated within the temperature range of 60-120F.
5. Applies only to applications without dynamic loads, and when the piping system is supported at intervals specified in LANL Engineering Standards or MSS standards.
6. Applies only to fittings which are procured with 1-1/3" and 2-3/4" Conflat flanges attached (i.e. elbows, tees, adapters) and/or to Conflat flange stainless steel weld fittings which are attached to fittings.
7. This alternate method does not apply to valves procured with Conflat flanges. There are other features on valves (i.e. bellows, packing) that are not associated with the Conflat flanged connection that must be analyzed separately. (Refer to alternate method VAR-2013-086.0, *Alternate Method for Continued Operation of TWTS Inlet Header with the Current Installed Valves and Conflat (CF) Flanges)*
8. Conflat fittings must be made with high-tensile strength nut/bolt fastener combinations with torque values of 7 ft-lb for 1-1/3" fittings and 12 ft-lb for 2-3/4" fittings. Regular nuts and bolts are not suitable for CF flange applications. Bolts/nut materials, gaskets, and fitting make-up must be in accordance with Conflat fitting manufacturer specifications and requirements.
   (Reference http://www.lesker.com/newweb/flanges/flanges_technicalnotes_conflat_1.cfm)

The evaluations presented in this Alternate Method include a combination of analyses, pressure tests and demonstrated successful service that meet the intent of ASME B31.3 300(c)(3) and 304.7.2.

This request is related to, and includes common reference documents to alternate method VAR-2013-086, *Alternate Method for Continued Operation of TWTS Inlet Header with Current installed Valves and Conflat Flanges.* VAR-2013-086 applies only to specific valves with Conflat fittings at WETF under the conditions stated in the alternate method.

Justification/Compensatory Measures:

1. A finite element stress analysis *Analysis of Conflat Flange Sets Subjected to Internal Pressures* per ASME Section VIII, Division I, Appendix 2 concluded that 2-3/4" OD 304 SS Conflat flanges with copper gaskets can withstand an internal pressure of 285 psig at room temperature. (Attachment 1)
2. A test report Indiana University *Leak Testing of Conflat-type Flanges Under Internal Pressure* concluded that 2-3/4" and 1-1/3" OD 304 SS Conflat flanges with copper gaskets pressurized to approximately 200 psig yielded no significant leak rated after cold cycling (2-6 cycles) between room temperature and <100K. (Attachment 2)
3. LANL W-7 test report *Proof and Leak Test of WETF Sensor Chamber Dwg 104Y-234083-14* (Attachment 3) documents that 2-3/4" OD Conflat (CF) flanges that were part of the WETF Sensor Chamber were pressure and leak tested on October 9, 2009 to a pressure of 250 psia (238.8 psig) for 8 minutes. The pressure in the WETF Sensor Chamber was then reduced to 225 psia and helium leak tested. The observed leak rate was less than 1x10-3 std cc/sec.
4. A piping header section in the WETF Tritium Waste Treatment System with 2-3/4" Conflat flanged fittings connected to Varian vacuum valves models L6591-301 and L8679-301 was pressure tested to 75 psig with a leak rate of less than 1x10-3 std cc/sec per WETF record WETF-02-687-R0, *TWTS Header RE-Route* (Attachment 4).
5. Vacuum valves models L6591-301 and L8679-301 with 2-3/4" Conflat flange connections were independently pressure and leak tested to 93 psia and 102 psia respectively with a leak rate of less than 1x10-3 std cc/sec. (Attachment 5, Group WX-5 Helium Leak Test Reports dated June 6th, 1986). It is noted that these specific two valves are approved for use in Alternate Method *VAR-2013-086, Alternate Method for continued operation of TWTS inlet header with the current installed valves and Conflat fittings* and are not the subject of this variance. These valves are referenced in this alternate method because of the pressure tests performed on these valves with Confat fittings. Valve model L6591-301 is HV-3-W in the WETF MEL and on drawing WETF-DR-TWTS-073.C and valve model L8679-301 is HV-2-W in the WETF MEL and on drawing WETF-DR-TWTS-073.C.
6. A Nupro 24VFBG valve with 2-3/4" Conflat flange connections pressure tested to 76 psig and leak-rate tested at 51 psig with a leak rate of less than 1x10-3 std cc/sec. (Attachment 6, W-7-AD-003U, Issue A, *GTS Proof and Leak Test Data Sheet*, dated 5/6/13.
7. Original Construction Specification for WETF (Attachment 7, *WETF Building Specification, TA-16, Bldg 205*) specified ½" and 1" stainless steel tubing with Conflat flange connections that were to have a design pressure of 50 psig and a test pressure of 75 psig. Although the original pressure test reports cannot be located and are presumed to be lost, WETF Tritium Waste Treatment System piping sections have been in extensive successful service with 2-3/4" and 1-1/3" Conflat flange connections in dual vacuum and pressure service up to 50 psig since 1986 with no record of failures or leakage.

Attachment 1: LANL report *Analysis of Conflat Flange Sets Subjected to Internal Pressures*, John C Ramsey, May 2010

Attachment 2: *Leak Testing of Conflat-type Flanges Under Internal Pressure, Indiana University,* October 2004

Attachment 3: LANL W-7 test report *Proof and Leak Test of WETF Sensor Chamber Dwg 104Y-234083-14,* 10/9/09

Attachment 4: Record WETF-02-687-R0, *TWTS Header RE-Route,* 9/4/02

Attachment 5: Group WX-5 Helium Leak Test Reports dated June 6th, 1986, (2 sheets)

Attachment 6: W-7-AD-003U, Issue A, *GTS Proof and Leak Test Data Sheet*, dated 5/6/13)

Attachment 7: *WETF Building Specification, TA-16, Bldg 205* (pertinent excerpt pages only attached)

Attachment 8: Conflat Information

Duration of Request:	Start Date:			End Date:	☒ Lifetime
Requestor Ed Hyde		Z Number 092739	Organization ES-WFO	Signature Signature on file	Date 6/18/15
USQD/USID required (Nucl. High/Mod Hazard)? ☐ Yes ☒ No			If Yes, USQD/USID Number		
Design Authority Representative Robert Swickley, ES-WFO		Z Number 228406	Organization ES-WFO	Signature Signature on file	Date 6/22/15
LANL Owning Manager (FOD or Programmatic) Brian Watkins		Z Number 206831	Organization WFO-FOD	Signature Signature on file	Date 6/25/15

3.0 Safety Management Program Owner (SMPO) Representative (SMPOR/POC)

☐ Decline ☐ Accept ☒ Accept Labwide ☒ with Modification: added web page info.

POC Ari Swartz	Z Number 235211	Signature Signature on file	Date 6/29/15

4.0 Additional Approval for P341 and APs; P342, ESM, Code, and Regulation Matters; and P343

☒ Accepted ☐ Accepted with comments ☐ Declined

Comments:

Safety or Security Management Program Owner Lawrence Goen	Z Number 106351	Signature Signature on file	Date 6/29/15

Conduct of Engineering
Request for Variance or Alternate Method

Assigned by SMPO or SMPOR: ☒ Alternate Method ☐ Variance Tracking number VAR-2015-045

Affected Document(s)

☐ Engineering Processes (e.g., P 341) ☐ Engineering Standards (e.g., P 342) ☐ Engineering Training & Qualification (e.g., P 343) If against P documents themselves, revision: ______	Subordinate (Functional Series) document if applicable (ESM Chapter, Master Spec, AP, etc.): Document Title/Number: Engineering Standards Manual STD-342-100 Chapter 17, Pressure Safety Revision: Rev. 0, 9/17/2014
Section/Para Section GEN - General Requirements GENERAL 1.0 A. Introduction and Applicability	
Specific Requirement(s) as Written in the Document(s) 5. 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 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.	

2.0 Request

Brief descriptive title: Acceptance of Relief Devices for Use at LANL for Pressure Systems Within the Scope of B31.3	
NCR required (work has occurred)? ☐ Yes ☒ No	If Yes, NCR Number
TA-Bldg-(Room) and/or Project Affected LANL	System/Component Affected Pressure systems requiring relief protection
Proposal Acceptance of ASME stamped devices as listed devices for pressures greater than 15 psig. Acceptance of non-ASME stamped devices as listed devices for pressures less than or equal to 15 psig.	
Justification/Compensatory Measures See Attachment **Summary** For all pressure systems:	

ASME stamped relief devices may be used as listed valves within the service conditions allowed by the manufacturer.

Un-stamped relief devices may be used less than or equal to 15 psig within the service conditions allowed by the manufacturer.

Un-stamped relief devices above 15 psig must be evaluated in accordance with ASME B31.3 304.7.2 *Unlisted Components,* and to the requirements of 322.6 *Pressure-Relieving Systems*.

Attachments:

- Justification/Compensatory Measures (3 pages with background citations)
- ASME B31.3 2014 Draft Response for Action Item: B-15-08
- ASME Presentation for ASME B&PVC Section XIII

Duration of Request:	Start Date: 05 05 2015		End Date:	☒ Lifetime
Requestor Ari Ben Swartz	Z Number 235211	Organization ES-EPD	Signature Signature on file	Date 5/5/15
USQD/USID required (Nucl. High/Mod Hazard)? ☐ Yes ☒ No		If Yes, USQD/USID Number		
Design Authority Representative Lawrence Kenneth Goen	Z Number 106351	Organization ES-DO	Signature	Date
LANL Owning Manager (FOD or Programmatic) Lawrence Kenneth Goen	Z Number 106351	Organization ES-DO	Signature	Date

3.0 Safety Management Program Owner (SMPO) Representative (SMPOR/POC)

☐ Decline ☐ Accept ☐ Accept Labwide ☐ with Modification:			
POC Ari Ben Swartz	Z Number 235211	Signature Signature on file	Date 5/5/15

4.0 Additional Approval for P341 and APs; P342, ESM, Code, and Regulation Matters; and P343

☒ Accepted ☐ Accepted with comments ☐ Declined			
Comments: Based on attached information			
Safety or Security Management Program Owner Lawrence Kenneth Goen	Z Number 106351	Signature Signature on file	Date 5/6/15

Justification/Compensatory Measures

The ASME B31 piping codes address relief devices differently. ASME B31.1 requires the devices meet ASME Boiler and Pressure Vessel Code (B&PVC) Section I *Rules for Construction of Power Boilers*, and Section VIII Division 1, *Rules for Construction of Pressure Vessels*.

ASME B31.3 is different. B31.3 only allows listed components and the only listed relief devices are those that comply with API 526 *Flanged Steel Pressure Relief Valves*. The B31.3 does not accept items in accordance with the ASME B&PVC Section I *Rules for Construction of Power Boilers*, or Section VIII Division 1, *Rules for Construction of Pressure Vessels*. Instead, it references only parts of the UG requirements for the relief devices that are contained in the ASME B&PVS VIII Division 1. One of the paragraph sections it does not include is UG-129 *Marking* so that a relief device does not require an ASME stamp to be used for B31.3 piping systems.

The ASME quality stamping program for relief devices is utilized as an industrial standard to ensure that a relief device functions properly at the correct temperature and pressure and relieves the rated quantity over time. The ASME B31.1 committees recognize the value of utilizing a stamped relief device as the main over pressure protection device.

I raised this issue during the biennial B31.3 committee meeting the design subgroup April 20 -23, 2015. An action item number B-15-08 was assigned. I have attached the paragraph change I recommended to 322.6.3 *Pressure-Relieving Devices*.

In addition, in a separate action the ASME has a request to create a new ASME &PVC Section XIII, *Rules for Overpressure Protection,* which received unanimous SCSVR approval. One of the major goals will be the consolidation and standardization of rules for relief protection.

Until such time as the ASME 322.6.3 rules are changed, the ASME stamped relief devises may be evaluated and accepted as unlisted components by applying 304.7.2 (a), so that LANL may accept an utilize the stamped relief devices by having “extensive, successful service under comparable conditions with similarly proportioned components of the same or like material” with this Alternative Method servicing as the documentation available for approval by the owner.

If an ASME stamped relief device set pressure is within the range allowed by the manufacture, the valve is rated for all the service temperatures and pressures, and the relief flow rates are equal to or greater than all challenges to meet the over pressure restriction of the B31.3 code the device may be considered as meeting the evaluation criteria for 304.7.2 (a).

For those systems where relief protection is required at less than or equal to 15 psig, and because no ASME stamp may be applied these relief devices shall be considered as listed when they meet the following criteria: 1) relief device set pressure is within the range allowed by the manufacture 2) the valve is rated for all the service temperatures and pressures, and 3) the relief flow rates are equal to or greater than all challenges to meet the over pressure restriction of the B31.3 code.

Summary

ASME stamped relief devices may be used as listed valves within the service conditions allowed by the manufacturer.

Un-stamped relief devices may be used less the 15 psig within the service conditions allowed by the manufacturer.

Un-stamped relief devices above 15 psig must be evaluate in accordance with ASME B31.3 304.7.2 *Unlisted Components.*

Background: Citations in ASME B31.3 and B31.1

ASME B31.3 2014

304.7.2 Unlisted Components. Pressure design of unlisted components to which the rules elsewhere in para. 304 do not apply shall be based on the pressure design criteria of this Code. The designer shall ensure that the pressure design has been substantiated through one or more of the means stated in subparas. (a) through (d) below. Note that designs are also required to be checked for adequacy of mechanical strength as described in para. 302.5. Documentation showing compliance with this paragraph shall be available for the owner's approval.

(a) extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.

(b) experimental stress analysis, such as described in the BPV Code, Section VIII, Division 2, Annex 5.F. (14)

(c) proof test in accordance with ASME B16.9, MSS SP-97, or Section VIII, Division 1, UG-101.

(d) detailed stress analysis (e.g., finite element method) with results evaluated as described in Section VIII, Division 2, Part 5. The basic allowable stress from Table A-1 shall be used in place of the allowable stress, S, in Division 2 where applicable. At design temperatures in the creep range, additional considerations beyond the scope of Division 2 may be necessary.

(e) For any of the above, the designer may interpolate between sizes, wall thicknesses, and pressure classes, and may determine analogies among related materials.

322.6.3 Pressure-Relieving Devices

(a) Pressure-relieving devices required by para. 301.2.2(a) shall be in accordance with the BPV Code, Section VIII, Division 1, UG-125(c), UG-126, UG-127, and UG-132 through UG-136, excluding UG-135(e) and UG-136(c). The terms design pressure[10] and piping system shall be substituted for maximum allowable working pressure and vessel, respectively, in these paragraphs. The required relieving capacity of any pressure-relieving device shall include consideration of all piping systems that it protects.

(b) Relief set pressure[11] shall be in accordance with Section VIII, Division 1, with the exceptions stated in alternatives (1) and (2), below.

(1) With the owner's approval the set pressure may exceed the limits in Section VIII, Division 1, provided that the limit on maximum relieving pressure stated in (c) below will not be exceeded.

(2) For a liquid thermal expansion relief device that protects only a blocked-in portion of a piping system, the set pressure shall not exceed the lesser of the system test pressure or 120% of design pressure.

(c) The maximum relieving pressure[12] shall be in accordance with Section VIII, Division 1, with the exception that the allowances in para. 302.2.4(f) are permitted, provided that all other requirements of para. 302.2.4 are also met.

[10] The design pressure for pressure relief is the maximum design pressure permitted, considering all components in the piping system.

[11] Set pressure is the pressure at which the device begins to relieve, e.g., lift pressure of a spring-actuated relief valve, bursting pressure of a rupture disk, or breaking pressure of a breaking pin device.

[12] Maximum relieving pressure is the

326 DIMENSIONS AND RATINGS OF
COMPONENTS

326.1 Dimensional Requirements

326.1.1 Listed Piping Components. Dimensional standards1 for piping components are listed in Table 326.1. Dimensional requirements contained in specifications listed in Appendix A

Flanged Steel Pressure-Relief Valves API 526 (contained in table 326.1)

ASME B31.1 2014

100.1 Scope

100.1.2

The valve or valves required by para. 122.1 are part of the boiler external piping, but do not require ASME Boiler and Pressure Vessel Code, Section I inspection and stamping except for safety, safety relief, and relief valves; see para. 107.8.2. Refer to PG-11.

component: component as used in this Code is defined as consisting of but not limited to items such as pipe, piping subassemblies, parts, valves, strainers, relief devices, fittings, etc.

ASME B31.1 2014

107.8.2 Pressure-Relieving Valves on Boiler External Piping.

Safety, safety-relief, and power-actuated pressure-relieving valves on boiler external piping shall be in accordance with para. 122.1.7(D.1) of this Code.

107.8.3 Pressure Relief Requirements on Nonboiler External Piping

(A) Reheater safety valves on reheat piping shall conform to para. 122.1.7(D.1).

(B) Safety, safety–relief, relief, and pilot-operated pressure relief valves shall be in accordance with UG-126 of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

(C) Nonreclosing pressure relief devices, such as rupture disks, pin devices/valves, and spring-loaded nonreclosing devices shall be in accordance with UG-127 of Section VIII, Division 1.

(D) Valves and devices in (B) and (C) above shall be constructed, manufactured, rated, and marked in accordance with the requirements of UG-128 through UG-132 and UG-136 through UG-138 of Section VIII, Division 1.

(E) An ASME Code Stamp and capacity certification are not required for valves with set pressures 15 psig [100 kPa (gage)] and lower.

107.8.4 Nonmandatory Appendix. For nonmandatory rules for the design of safety valve installations, see Nonmandatory Appendix II of this Code.

122.1.7 Valves and Fittings.

(D) Pressure-Relieving Valves

(D.1) Safety, safety–relief, and power-actuated pressure-relieving valves shall conform to the requirements of PG-67, PG-68, PG-69, PG-70, PG-71, PG-72, and PG-73 of Section I of the ASME Boiler and Pressure Vessel Code.

126 MATERIAL SPECIFICATIONS AND STANDARDS
FOR STANDARD AND NONSTANDARD PIPING
COMPONENTS

126.1 Standard Piping Components

Dimensions of standard piping components shall comply with the standards and specifications listed in Table 126.1 in accordance with para. 100.

Table 126.1 (no reference for relief device standard)

ASME B31.3 2014 Draft Response for Action Item: B-15-08
PART 6
SYSTEMS
322 SPECIFIC PIPING SYSTEMS

Item Number	Existing Code (ASME B31.3 2014)	Proposed Revision (redlined mode)	Proposed Revision (redlines accepted)	Comments
1	**322.6.3 Pressure-Relieving Devices** *(a)* Pressure-relieving devices required by para. 301.2.2 (a) shall be in accordance with the BPV Code, Section VIII, Division 1, UG-125(c), UG-126, UG-127, and UG-132 through UG-136, excluding UG-135(e) and UG-136(c). The terms *design pressure*[10] and *piping system* shall be substituted for *maximum allowable working pressure* and *vessel*, respectively, in these paragraphs. The required relieving capacity of any pressure-relieving device shall include consideration of all piping systems that it protects. *(b)* Relief set pressure[11] shall be in accordance with Section VIII, Division 1, with the exceptions stated in alternatives (1) and (2), below. *(1)* With the owner's approval the set pressure may exceed the limits in Section VIII, Division 1, provided that the limit on maximum relieving pressure stated in (c) below will not be exceeded.	**322.6.3 Pressure-Relieving Devices** *(a)* Pressure-relieving devices required by para. 301.2.2 (a) shall be in accordance with the BPV Code, Section VIII, Division 1, The terms *design pressure*[10] and *piping system* shall be substituted for *maximum allowable working pressure* and *vessel*, respectively, in these paragraphs. The required relieving capacity of any pressure-relieving device shall include consideration of all piping systems that it protects. (1) Safety, safety–relief, relief, and pilot-operated pressure relief valves shall be in accordance with UG-126 of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. (2) Nonreclosing pressure relief devices, such as rupture disks, pin devices/valves, and spring-loaded nonreclosing devices shall be in accordance with UG-127 of	**322.6.3 Pressure-Relieving Devices** *(a)* Pressure-relieving devices required by para. 301.2.2 (a) shall be in accordance with the BPV Code, Section VIII, Division 1. The terms *design pressure*[10] and *piping system* shall be substituted for *maximum allowable working pressure* and *vessel*, respectively, in these paragraphs. The required relieving capacity of any pressure-relieving device shall include consideration of all piping systems that it protects. *(1)* Safety, safety–relief, relief, and pilot-operated pressure relief valves shall be in accordance with UG-126 of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. *(2)* Nonreclosing pressure relief devices, such as rupture disks, pin devices/valves, and spring-loaded nonreclosing devices shall be in accordance with UG-127 of	The ASME B&PVC Section I, Section III, Section IV, Section VIII, Section X (references Section VIII), Section XII (references Section VIII), and B31.1 require ASME stamped relief devices. ASME B31.1 does not cite API 526, *Flanged Steel Pressure-relief Valves*, as a listed item. Instead they directly reference the items in the ASME Section I or Section VIII. This proposed change will not affect the application of the API 526 because it requires that relief devices be "designed and manufactured in accordance with the applicable requirements of ASME BPVC, Section VIII for pressure-relief devices". ASME is requesting a new ASME B&PVC Section XIII, *Rules for Overpressure Protection*, that will consolidate all overpressure protection technology into one book for the benefit of all stakeholders. Table 326.1 **B31.1-2014, *Power Piping*** **107.8 Pressure-Relieving Valves and Devices** **107.8.1 General.** Pressure-relieving valves and devices shall conform to the requirements specified in this Code for flanges, valves, and fittings for the pressures

Item Number	Existing Code (ASME B31.3 2014)	Proposed Revision (redlined mode)	Proposed Revision (redlines accepted)	Comments
	(2) For a liquid thermal expansion relief device that protects only a blocked-in portion of a piping system, the set pressure shall not exceed the lesser of the system test pressure or 120% of design pressure. *(c)* The maximum relieving pressure[12] shall be in accordance with Section VIII, Division 1, with the exception that the allowances in para. 302.2.4(f) are permitted, provided that all other requirements of para. 302.2.4 are also met.	Section VIII, Division 1. (3) Valves and devices in (1) and (2) above shall be constructed, manufactured, rated, and marked in accordance with the requirements of UG-128 through UG-132 and UG-136 through UG-138 of Section VIII, Division 1. (4) An ASME Code Stamp and capacity certification are not required for valves with set pressures 15 psig [100 kPa (gage)] and lower. *(b)* Relief set pressure[11] shall be in accordance with Section VIII, Division 1, with the exceptions stated in alternatives (1) and (2), below. *(1)* With the owner's approval the set pressure may exceed the limits in Section VIII, Division 1, provided that the limit on maximum relieving pressure stated in (c) below will not be exceeded. *(2)* For a liquid thermal expansion relief device that protects only a blocked-in portion of a piping system, the set pressure shall not exceed the lesser of the system test pressure or 120% of design pressure.	Section VIII, Division 1. *(3)* Valves and devices in (1) and (2) above shall be constructed, manufactured, rated, and marked in accordance with the requirements of UG-128 through UG-132 and UG-136 through UG-138 of Section VIII, Division 1. *(4)* An ASME Code Stamp and capacity certification are not required for valves with set pressures 15 psig [100 kPa (gage)] and lower. *(b)* Relief set pressure[11] shall be in accordance with Section VIII, Division 1, with the exceptions stated in alternatives (1) and (2), below. *(1)* With the owner's approval the set pressure may exceed the limits in Section VIII, Division 1, provided that the limit on maximum relieving pressure stated in (c) below will not be exceeded. *(2)* For a liquid thermal expansion relief device that protects only a blocked-in portion of a piping system, the set pressure shall not exceed the lesser of the system test pressure or 120% of design pressure.	and temperatures to which they may be subjected. **107.8.2 Pressure-Relieving Valves on Boiler External Piping.** Safety, safety-relief, and power-actuated pressure-relieving valves on boiler external piping shall be in accordance with para. 122.1.7(D.1) of this Code. **107.8.3 Pressure Relief Requirements on Nonboiler External Piping** *(A)* Reheater safety valves on reheat piping shall conform to para. 122.1.7(D.1). *(B)* Safety, safety–relief, relief, and pilot-operated pressure relief valves shall be in accordance with UG-126 of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. *(C)* Nonreclosing pressure relief devices, such as rupture disks, pin devices/valves, and spring-loaded nonreclosing devices shall be in accordance with UG-127 of Section VIII, Division 1. *(D)* Valves and devices in (B) and (C) above shall be constructed, manufactured, rated, and marked in accordance with the requirements of UG-128 through UG-132 and UG-136 through UG-138 of Section VIII, Division 1. *(E)* An ASME Code Stamp and capacity certification are not required for valves with set pressures 15 psig [100 kPa (gage)] and lower. **107.8.4 Nonmandatory Appendix.** For nonmandatory rules for the design of safety valve installations, see Nonmandatory Appendix II of this Code. *(D) Pressure-Relieving Valves* *(D.1)* Safety, safety–relief, and power-actuated pressure-relieving valves shall conform to the requirements of PG-67, PG-68, PG-69, PG-70, PG-

Item Number	Existing Code (ASME B31.3 2014)	Proposed Revision (redlined mode)	Proposed Revision (redlines accepted)	Comments
		(c) The maximum relieving pressure[12] shall be in accordance with Section VIII, Division 1, with the exception that the allowances in para. 302.2.4(f) are permitted, provided that all other requirements of para. 302.2.4 are also met. Note: Other relief devices may be used provided an evaluation is performed in accordance with paragraph 304.7.2.	*(c)* The maximum relieving pressure[12] shall be in accordance with Section VIII, Division 1, with the exception that the allowances in para. 302.2.4(f) are permitted, provided that all other requirements of para. 302.2.4 are also met. Note: Other relief devices may be used provided an evaluation is performed in accordance with paragraph 304.7.2.	71, PG-72, and PG-73 of Section I of the ASME Boiler and Pressure Vessel Code. **API Standard 526 Sixth Edition, April 2009, Errata, May 2009, Errata 2, October 2012,** ***Flanged Steel Pressure-relief Valves*** **7 Design** **7.1 General** Pressure-relief valves discussed in this standard shall be designed and manufactured in accordance with the applicable requirements of ASME BPVC, Section VIII for pressure-relief devices.
2	(Table 326.1) Flanged Steel Pressure-Relief Valves. . . . . API 526			Remove reference to API 526 from Table 326.1

SETTING THE STANDARD

Request for the Development of a New ASME Standards Activity

Section XIII – Rules for Overpressure Protection

October 20, 2014

What

- Consolidate all overpressure protection technology into one book for the benefit **all stakeholders**
- Advance the technology with participation by a broader SME pool
- The application of that technology:
  – Remains with the book committees
  – Be available for non-vessel stakeholders

Why

- Many requirements are duplicated in multiple books
- Structure delays and/or discourages the adoption of new technology
  - Pressure relief valves for < 15 psig
- ASME does not have a single internationally recognized document such as ISO 4126
  - ASME Vessels and Boilers with ISO 4126 pressure relief devices
- Devices used for piping, pumps, compressors, turbines, etc.

Section XIII – Rules for Overpressure Protection

ASME Request for Development of a New Standard

C&SC
13-663

Unanimous
SCSVR
Approval

Request for the Development of a New ASME Standards Activity
13-663 January 16, 2014

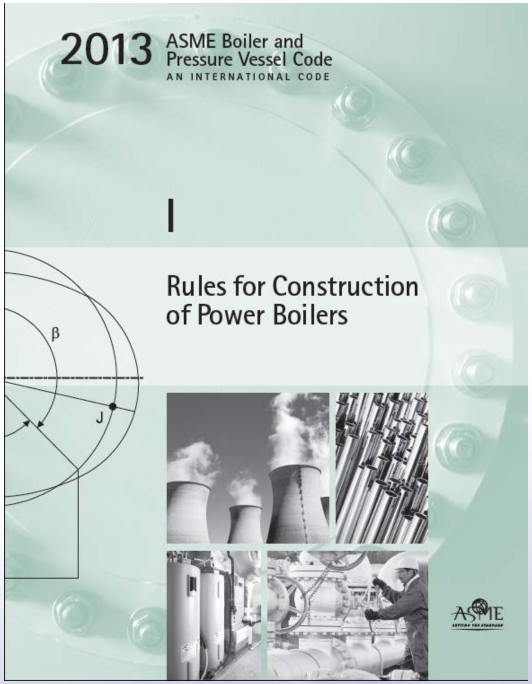
1.	**Provide the title and scope of the proposed standard. [Note: This includes technical reports and guides.]** Title: Boiler & Pressure Code Section XIII – Rules for Overpressure Protection Scope: This standard provides the requirements for pressure relief devices or system design used to protect against overpressure in pressurized equipment. It establishes rules for each type of pressure relief device including materials, design, construction, settings, testing, and capacity certification as well as performance testing and installation requirements for pressure relief devices and conceptual requirements for system design. See Supplement
2.	**Identify the affected stakeholders/users and the need(s) the proposed standard is intended to address. If possible, provide reference materials (including documents suitable as the basis for a first draft).** The affected stakeholders/users include: 1) BPV Standards Committees 2) BPV Certificate Holders 3) Other Sections and Divisions of the BPV Code, Piping Codes and other National and International Standards/Regulations/Directives 4) International pressure relief device manufacturers that are not ASME certificate holders 5) Pressure relief manufacturers of non-ASME certification marked devices (i.e. < 15 psig) 6) Users including - Jurisdictions - Equipment owners/operators including their engineering staffs - Design Firms - Relief device repair organizations - Insurance and inspection agencies There are many Recognized and Generally Accepted Good Engineering Practice's (RAGAGEP's) that address various aspects of pressure relief systems but none can be considered a comprehensive resource. This new standard is needed to bring uniformity to the requirements for overpressure protection devices, not only within the ASME Codes, but for all industries and users. The long term objective of this new Standard will be to consolidate rules and be the essential resource for overpressure protection.

Questionnaire
+
Supplement

Section XIII – Rules for Overpressure Protection

Not in Scope

- Rules of Application remain with the equipment Codes
  - Type of device
  - Number of devices
  - Overpressure
  - Required Relieving Capacity
  - i.e. - PG-67
- Conformity Assessment (CA-1)
  - Quality Programs



Section XIII – Rules for Overpressure Protection

Scope

- Content drawn from existing ASME Standards
  - BPV Sections I, III, IV, VIII, X and XII
  - PTC 25

- Rules for Pressure Relief Devices
  - Materials
  - Design
  - Construction
  - Testing
  - Settings
  - Capacity Certification
  - Performance Testing
  - Installation Requirements

Section XIII – Rules for Overpressure Protection

Scope

- Other pressurized equipment
  - Piping
  - Rotating Equipment
  - Low Pressure Vessels (< 15 psi)
  - Vacuum Protection
- Rules of OPP System Design
  - Guidance on elements of a system design
  - Not rules for the detail design of OPP systems
  - UG-140
- Future Scope Potential (Rules or Reference to Existing Standards)
  - Design Rules for PRDs
  - Material requirements more appropriate for PRDs
  - In-Service & Maintenance Rules
  - Broader Application Rules or Guidelines

ASME
SETTING THE STANDARD

Section XIII – Rules for Overpressure Protection

Stakeholders/Users

- BPV Standards Committees
- BPV Certificate Holders
- Other Sections and Divisions of the BPV Code, Piping Codes and other National and International Standards/Regulations/Directives
- International PRD manufacturers that are not ASME certificate holders
- PRD manufacturers of non-ASME certification marked devices
  - < 15 psig including vacuum
- Users including
  - Jurisdictions
  - Equipment owners/operators including their engineering staffs
  - Engineering/Design Firms
  - Relief device repair organizations
  - Insurance and inspection agencies

Section XIII – Rules for Overpressure Protection

OPP Standards Committee Membership

- Users
- Regulatory
- Manufacturers
- Construction Book Members Including Nuclear
- Materials
- International Representation
- Piping
- Testing Labs

Section XIII – Rules for Overpressure Protection

Jurisdictional and Legal Impact

- No expected impact to Jurisdictional requirements

- Application of XIII rules invoked by Construction Code

Section XIII – Rules for Overpressure Protection

Expected Benefits

- Elevates the technology to same level as protected equipment
- Increase understanding and knowledge
- Streamlines process of change and innovation
- Efficient use of ASME/Volunteer resources
- Aligns with Standards Evolution and Modernization Efforts
- Regains ASME Global Leadership

ENHANCES PUBLIC SAFETY

Section XIII – Rules for Overpressure Protection

Vision

- Consolidation and Standardization
- Comprehensive Resource
  - Pressure Relief Devices
  - Pressurized Equipment
  - OPP Systems
- Uniformity
- Global Relevance

THE ESSENTIAL RESOURCE for OVERPRESSURE PROTECTION

ASME
SETTING THE STANDARD

Questions and Discussion

ASME

SETTING THE STANDARD

Los Alamos
NATIONAL LABORATORY
EST.1943

Conduct of Engineering
Formal Clarification or Interpretation Request

Assigned by Responder: ☐ Clarification ☒ Interpretation Tracking number ESM-CIR-2015-005

Clarify	To make the CoE document or its references understandable and free from confusion
Interpret	To formally provide an acceptable method of compliance with the document or references

1.0 Request

Brief Title:

Affected Document Title, Number, and Rev. No.

Engineering Standards Manual STD-342-100 Chapter 17, Pressure Safety, Revision: 0, 9/17/2014

Section/Article/Para and Existing Wording

Section GEN - General Requirements

GENERAL 1.0

A. Introduction and Applicability

5. 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 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.

Section ADMIN - Administrative Requirements Rev. 0, 9/17/2014

ADMIN-2 Design, Documentation, and Records

Z. Unlisted, Specialty, or Unique Components[25]

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 and ASME B31.1 requires a safety factor of 4:1. For existing systems, refer to Chapter 17 Section EXIST.

   a. Swagelok components (tubing, fittings, and valves only) are allowed for use in construction of new, code-compliant systems at LANL.[26] See Section Attachment ASME-4-2 for flex hose.

2. The master list of Unlisted Components allowed for use is maintained by the CPSO and made available for both internal and external web access.

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 (per the code of record) as follows (B31.3 302.2.3):

   a. Unlisted Components - (a) Components not listed in Table 326.1, but which conform to a published specification or standard may be used within the following limitations.

      1) The designer shall be satisfied that composition, mechanical properties, method of manufacture, and quality control are comparable to the corresponding characteristics of listed components.
      2) Pressure design shall be verified in accordance with para. 304:

         304 PRESSURE DESIGN OF COMPONENTS
         304.1 Straight Pipe
         304.2 Curved and Mitered Segments of Pipe
         304.3 Branch Connections
         304.4 Closures
         304.5 Pressure Design of Flanges and Blanks
         304.6 Reducers
         304.7 Pressure Design of Other Components

ES-DO 2015-202

NOTE: Items that are not evaluated per 304.1, 304.2, 304.3, 304.4, 304.5, or 304.6 MUST BE evaluated by 304.7.

3) Other unlisted components shall be qualified for pressure design as required by para. 304.7.2.

4) Components built at LANL

a. Require qualification by engineering calculation to support pressure design consistent with the applicable code. Documentation showing compliance with the design criteria of the code approved by the owner shall be by one of the following:

i. Extensive successful service under the same loading and service conditions

ii. Experimental stress analysis[27]

iii. Proof test (e.g., Sect VIII UG-101 would be 4 times MAWP)

iv. Detailed stress analysis (such as finite element method)[28]

Inquiry (describe ambiguity or issue)

Are ASME Code stamped relief devices (e.g. UV, HV, SV, etc…) required to be evaluated as unlisted items for ASME B31.9 applications?

Requestor (LANL employee)	Z Number	Organization	Date
Ari Ben Swartz	235211	ES-EPD	06/17/2015

2.0 Response by Safety (or Security) Management Program Owner Representative (SMPOR/POC)

For all pressure systems:

ASME stamped relief devices may be used as listed valves within the service conditions allowed by the manufacturer.

Un-stamped relief devices may be used less than or equal to 15 psig within the service conditions allowed by the manufacturer.

Un-stamped relief devices above 15 psig must be evaluated in accordance with ASME B31.9 904.7.2, *Unlisted Components,* 907.1.2 *Unlisted Valves.*, and the requirements of 922, *Design Requirements Pertaining to Specific Piping Systems.*

Attachment:

- Justification/Compensatory Measures (4 pages)

Name	Z Number	Signature	Date
Ari Ben Swartz	235211	Ari Ben Swartz	6/17/2015

3.0 SMPO Approval (Standards Manual and code and regulation matters only, otherwise N/A)

Comments

Name	Z Number	Signature	Date
MEL BURNETT FOR Lawrence Kenneth Goen	106351	[signature]	6/18/15

Distribution: Requestor, SMPOR, SMPO, CENG-OFF Program POC

Justification/Compensatory Measures

The ASME B31 piping codes address relief devices differently. ASME B31.1 requires the devices meet ASME Boiler and Pressure Vessel Code (B&PVC) Section I *Rules for Construction of Power Boilers*, and Section VIII Division 1, *Rules for Construction of Pressure Vessels.*

The ASME B31.9-2014 requires listed components, gives methods to use unlisted valves, and allows the use of components from ASME B31.1.

> 902.2 Pressure–Temperature Design Criteria for Piping Components
>
> 902.2.1 Components Having Specific Ratings
>
> (a) For Listed Components. Pressure–temperature ratings have been established for certain piping components and are contained in some of the standards listed in Table 926.1. These ratings are accepted for use in accordance with this Code.
>
> (b) For Components Not Listed. If it is necessary to use components that do not conform to standards listed in Table 926.1, they shall be qualified for pressure design in accordance with the requirements of **para. 904.** In addition, they shall be used within the ratings and other service limitations given by the manufacturer.
>
> 904.7.2 Unlisted Components. Pressure containing components made of listed materials but not made in accordance with a specification or standard listed in Table 926.1 or Mandatory Appendix I shall be substantiated by at least one of the following:
>
> (a) engineering calculations
>
> (b) experimental stress analysis such as described in Part 5 in Section VIII, Division 2 of the ASME BPV Code
>
> (c) proof test in accordance with UG-101 in Section VIII, Division 1 of the ASME BPV Code If differences in size and proportion are small, components may be designed by interpolation between similar configurations that have been proven by one of the procedures described above, or that conform to a listed standard.
>
> 907 VALVES
>
> 907.1 General
>
> 907.1.2 Unlisted Valves. Valves not manufactured in accordance with a listed standard **shall be used only within the manufacturer's recommendations as to service and ratings, and within the limitations on comparable listed valves, considering composition, mechanical properties, dimensions, method of manufacture, and quality control.** Otherwise, the valves shall be qualified in accordance with para. 904.7.2.
>
> 926 DIMENSIONS AND RATINGS OF COMPONENTS
>
> 926.1 Standard Piping Components Standard piping components shall conform to one of the standards or specifications listed in Table 926.1. **Those listed in ASME B31.1 may also be used.**

The ASME B31.9 allows ASME B31.1listed items, and allows valves to be used in accordance with 904.1.2.

The ASME quality marking program for relief devices is utilized as an industrial standard to ensure that a relief device functions properly at the correct temperature and pressure and relieves the rated quantity over time. The ASME B31.1 committees recognize the value of utilizing a marked relief device as the main over pressure protection device.

The ASME B31.1 requires the use of ASME marked valves for steam and non-steam applications as follows:

B31.1-2014 POWER PIPING Chapter I Scope and Definitions

100.1.2

The valve or valves required by para. 122.1 are part of the boiler external piping, but do not require ASME Boiler and Pressure Vessel Code, Section I inspection and stamping except for safety, safety relief, and relief valves; see para. 107.8.2. Refer to PG-11.

107.8.2 Pressure-Relieving Valves on Boiler External Piping. Safety, safety-relief, and power-actuated pressure-relieving valves on boiler external piping shall be in accordance with para. 122.1.7(D.1) of this Code.

107.8.3 Pressure Relief Requirements on Nonboiler External Piping

(A) Reheater safety valves on reheat piping shall conform to para. 122.1.7(D.1).

(B) Safety, safety–relief, relief, and pilot-operated pressure relief valves shall be in accordance with UG-126 of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

(C) Nonreclosing pressure relief devices, such as rupture disks, pin devices/valves, and spring-loaded nonreclosing devices shall be in accordance with UG-127 of Section VIII, Division 1.

(D) Valves and devices in (B) and (C) above shall be constructed, manufactured, rated, and **marked in accordance with the requirements of UG-128 through UG-132** and UG-136 through UG-138 of Section VIII, Division 1.

(E) An ASME Code Stamp and capacity certification are not required for valves with set pressures 15 psig [100 kPa (gage)] and lower.

2013 ASME Boiler and Pressure Vessel Code Section VIII, *Rules for Construction of Pressure Vessels*, Division 1

UG-129 MARKING

(a) Safety, Safety Relief, Relief, Liquid Pressure Relief, and Pilot Operated Pressure Relief Valves. Each safety, safety relief, relief, liquid pressure relief, and pilot operated pressure relief valve NPS 1/2 (DN 15) and larger shall be plainly marked by the Manufacturer or Assembler with the required data in such a way that the marking will not be obliterated in service. The marking may be placed on the valve or on a metal plate or plates securely fastened to the valve.

Note UG-129 continues to the sections that specify the marking requirements for example:

(7) the Certification Mark with the UV Designator placed under the Mark, as shown in **Figure UG-129.1**. A marking method other than the stamp issued by the Society may be used provided it is acceptable to the ASME designated organization.

Figure UG-129.1
Official Certification Mark to Denote the American Society of Mechanical Engineers' Standard for Pressure Relief Valves

UV

UG-130 CERTIFICATION MARK

Each pressure relief device[59] **to which the Certification Mark with the appropriate Designator (see Figures UG-129.1 and UG-129.2)** will be applied shall have been fabricated or assembled by a Manufacturer or Assembler holding a valid Certificate of Authorization (UG-117) and capacity certified in accordance with the requirements of this Division. A Certified Individual (CI) shall provide oversight as required by UG-117(a). Each use of the Certification Mark with the appropriate Designator shall also be documented on a Certificate of Conformance Form UV-1 or UD-1, as appropriate.

122.1.7 Valves and Fittings

(D) Pressure-Relieving Valves

(D.1) Safety, safety–relief, and power-actuated pressure-relieving valves shall conform to the requirements of PG-67, PG-68, **PG-69**, PG-70, PG-71, PG-72, and PG-73 of Section I of the ASME Boiler and Pressure Vessel Code.

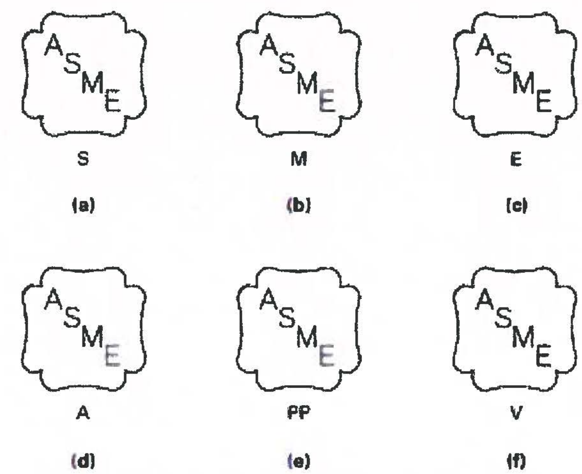
PG-69 CERTIFICATION OF CAPACITY OF PRESSURE RELIEF VALVES

PG-69.4 Power-actuated pressure relieving valves, having capacities certified in accordance with the provision of PG-69.3 and computed in accordance with the formula contained therein, **shall be marked as required by PG-110** with the computed capacity, corresponding to 3% above the full load operating pressure and temperature conditions at the valve inlet when the valve is operated by the controller, and they shall also be stamped with the set pressure of the controller. When the valve is marked as required by this paragraph, it shall be the guarantee by the manufacturer that the valve also conforms to the details of construction herein specified.

PG-110 STAMPING OF BOILER PRESSURE RELIEF

VALVES
(g) Certification Mark as shown in **Figure PG-105.1** with a "V" Designator placed under the Certification Mark. A marking method other than the stamp issued by the Society may be used, provided that it is acceptable to the ASME designated organization.

Figure PG-105.1
Official Certification Mark to Denote the American Society of Mechanical Engineers' Standard for Boilers



2013 ASME Boiler and Pressure Vessel Code Section I, *Rules for Construction of Power Boilers.*
PG-69 CERTIFICATION OF CAPACITY OF PRESSURE RELIEF VALVES
PG-69.1 Before the Certification Mark is applied to any pressure relief valve or power-actuated pressure relieving valve, the valve manufacturer shall have the relieving capacity of his pressure relief valves certified in accordance with the provisions of this paragraph.

The ASME B&PVC Section I and VIII Division 1 marked valves meet the requirements B31.1 and B31.9 907.1.2. LANL will treat the ASME B&PVC Section I and VIII Division 1 marked valves as listed items for B31.9.

Table of Contents

1.0 NEW FABRICATION **1**
A. Application of Codes 1
2.0 ATTACHMENTS **3**
Attachment ASME-1 – Code and Regulation Application 3
Attachment ASME -2 – (reserved for future use) 3
Attachment ASME -3 – Category M Fluids 3
Attachments ASME -4-X – Acceptable Items for Code Construction 3
Attachment ASME -4-1 Designer-Approved Alternative Hose Restraints 3
Attachment ASME -4-2 Swagelok Flex Hoses 3

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Revision of content formerly in Section I, Rev. 3.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Chapter POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

1.0 NEW FABRICATION

All boilers, pressure vessels, air receivers, and supporting piping shall meet the appropriate ASME Boiler and Pressure Vessel Code Section, and B31 piping section as applicable.

A. Application of Codes

1. ASME Code-Stamped Boilers and Vessels

   a. A manufacturer holding an ASME Code stamp as defined by the applicable ASME B&PVC Section must be designed and have vessel stamped accordingly.

b. A copy of the manufacturer's data reports (e.g.,"P-2", "U1", "U1A", "U2", etc.) must be supplied with the vessel, and must be maintained in the pressure system documentation package. An NBIC registration number must be applied to the item.

c. For pressure vessels without an ASME stamp, the ASME Code design calculations must be obtained [e.g., LANS or an external design agency (Architect/Engineer)].

d. Receipt inspection of fabricated vessels must include verification of manufacturer's data reports (e.g., "P2", "U1" form, etc.), and visual identification of appropriate stamping, or availability of design calculations.

e. Installation of new boilers shall comply with NBIC Section I, Installation.

2. Repairs and Alterations

a. Repairs and alterations that require welding to code stamped vessels ("S", "H", "U", "U2", etc.) must be performed as instructed per the applicable ASME Boiler and Pressure Vessel Section (as referenced by NBIC NB-23), and must be performed by an institution holding an "R" stamp.

b. ASME PCC-2 must be used as a guide for repair of pressure equipment and piping.

c. Repairs to support piping and piping components must be performed as defined in ASME B31.1 or other applicable B31 piping code.

d. Repairs to pressure relief, or pressure safety valves displaying the "UV" stamp, must be performed by an institution holding a "VR" stamp.

e. Repairs and modifications to pressure vessels and piping must be verified through engineering calculations prior to performing the operation.

f. Completion of repairs (including routine 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 system's documentation package.

g. 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.

h. Boilers: Repair or alteration of boilers must meet New Mexico Administrative Code (NMAC) 14.9.4 "Housing and Construction, Mechanical Codes, Boilers."

1) Routine repairs as defined by NB-23 include re-tubing a boiler when no welding is performed.

2) NMAC 14.9.4 requires boilers be maintained and operated in compliance with the manufacturer's requirements.

2.0 ATTACHMENTS

Attachment ASME-1 – Code and Regulation Application

Attachment ASME -2 – (reserved for future use)

Attachment ASME -3 – Category M Fluids

Attachments ASME -4-X – Acceptable Items for Code Construction

Attachment ASME -4-1 Designer-Approved Alternative Hose Restraints

Attachment ASME -4-2 Swagelok Flex Hoses

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Code and Regulation Application

This attachment contains paraphrased code and regulation scope summaries with discussion of how these mandates shall be applied at LANL.[1]

[1] Many of these mandates and their adoption by LANL are listed in SD100, *Integrated Safety Management System Description Document with embedded 10 CFR 851 Worker Safety and Health Program.*

Attachment ASME - 1 – Code and Regulation Application

B31.1 Power Piping

Power piping systems include but are not limited to steam, water, oil, gas, and air services. This Code covers boiler external piping and non-boiler external piping for power boilers and high temperature, high pressure water boilers in which: steam or vapor is generated at a pressure of more than 15 psig [100 kPa (gage)]; and high temperature water is generated at pressures exceeding 160 psig [1,103 kPag] and/or temperatures exceeding 250°F (120°C).

This Code does not apply to building heating and distribution steam and condensate piping designed for 15 psig [100 kPag] or less, or hot water heating systems designed for 30 psig [200 kPag] or less.

B31.2 Fuel Gas Piping

LANL does not follow this code. This code has been withdrawn and replaced by NFPA 54, *National Fuel Gas Code*. The authority having jurisdiction of NFPA 54 is the DOE/LANL Fire Marshal.

B31.3 Process Piping

Pressure greater than 15 psig or if the fluid is flammable, toxic, or damaging to human tissues as defined in ASME B31.3 300.2 or the design temperature is outside the range of −29°C (−20°F) through 186°C (366°F). Toxic is defined as a category M fluid. Category M fluids are identified in ESM Chapter 17 Att. II-4.

B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

LANL does not apply this code because there are no known systems that are within the scope of the code.

This Code prescribes requirements for the design, materials, construction, assembly, inspection, and testing of piping transporting liquids such as crude oil, condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, carbon dioxide, liquid alcohol, liquid anhydrous ammonia, and liquid petroleum products between producers' lease facilities, tank farms, natural gas processing plants, refineries, stations, ammonia plants, terminals (marine, rail, and truck), and other delivery and receiving points.

This Code does not apply to (a) auxiliary piping, such as water, air, steam, lubricating oil, gas, and fuel (b) pressure vessels, heat exchangers, pumps, meters, and other such equipment including internal piping and connections for piping except as limited by para. 423.2.4(b) (c) piping designed for internal pressures (1) at or below 15 psi (1 bar) gage pressure regardless of temperature(2) above 15 psi (1 bar) gage pressure if design temperature is below minus 20°F (−30°C) or above 250°F (120°C)

B31.5 Refrigeration Piping and Heat Transfer Components

This Code prescribes requirements for the materials, design, fabrication, assembly, erection, test, and inspection of refrigerant, heat transfer components, and secondary coolant piping for temperatures as low as −320°F (−196°C), whether erected on the premises or factory assembled, except as specifically excluded in the following paragraphs.

This Code shall not apply to any of the following: (a) any self-contained or unit systems subject to the requirements of Underwriters Laboratories or other nationally recognized testing laboratory (b) water piping, other than where water is used as a secondary coolant or refrigerant (c) piping designed for external or internal gage pressure not exceeding 15 psi (105 kPa) regardless of size (d) pressure vessels, compressors, or pumps, but does include all connecting refrigerant and secondary coolant piping starting at the first joint adjacent to such apparatus

B31.8 Gas Transmission and Distribution Piping Systems

Note: These systems are also be required to meet DOE O 460.1 *Packaging and Transportation Safety* requiring 49 CFR 190-193, 195, and 199

802.1 Scope

(a) This Code covers the design, fabrication, installation, inspection, and testing of pipeline facilities used for the transportation of gas. This Code also covers safety aspects of the operation and maintenance of those facilities. (See Appendix Q for scope diagrams.) This Code is concerned only with certain safety aspects of liquefied petroleum gases when they are vaporized and used as gaseous fuels. All of the requirements of NFPA 58 and NFPA 59 and of this Code concerning design, construction, and operation and maintenance of piping facilities shall apply to piping systems handling butane, propane, or

mixtures of these gases.

(b) This Code does not apply to

(1) design and manufacture of pressure vessels covered by the BPV Code[1]

(2) piping with metal temperatures above 450°F (232°C) or below −20°F (−29°C) (for low temperature considerations, see para. 812.)

(3) piping beyond the outlet of the customer's meter set assembly (refer to ANSI Z223.1/NFPA 54.)

(4) piping in oil refineries or natural gasoline extraction plants, gas treating plant piping other than the main gas stream piping in dehydration, and all other processing plants installed as part of a gas transmission system, gas manufacturing plants, industrial plants, or mines (See other applicable sections of the ASME Code for Pressure Piping, B31.)

(5) vent piping to operate at substantially atmospheric pressures for waste gases of any kind

(6) wellhead assemblies, including control valves, flow lines between wellhead and trap or separator, offshore platform production facility piping, or casing and tubing in gas or oil wells (For offshore platform production facility piping, see API RP 14E.)

(7) the design and manufacture of proprietary items of equipment, apparatus, or instruments

(8) the design and manufacture of heat exchangers (refer to appropriate TEMA[2] standard.)

(9) liquid petroleum transportation piping systems (refer to ASME B31.4.)

(10) liquid slurry transportation piping systems (refer to ASME B31.11.)

(11) carbon dioxide transportation piping systems

(12) liquefied natural gas piping systems (refer to NFPA 59A and ASME B31.3.)

(13) cryogenic piping systems

[1] BPV Code references here and elsewhere in this Code are to the ASME Boiler and Pressure Vessel Code.
[2] Tubular Exchanger Manufacturers Association, 25 North Broadway, Tarrytown, NY 10591.

B31.8S Managing System Integrity of Gas Pipelines

This Code applies to onshore pipeline systems constructed with ferrous materials and that transport gas. The principles and processes embodied in integrity management are applicable to all pipeline systems.

This Code is specifically designed to provide the operator (as defined in section 13) with the information necessary to develop and implement an effective integrity management program utilizing proven industry practices and processes. The processes and approaches within this Code are applicable to the entire pipeline system.

B31.9 Building Services Piping

This Code Section has rules for the piping in industrial, institutional, commercial, and public buildings, and multi-unit residences, which does not require the range of sizes, pressures, and temperatures covered in B31.1.

(a) Services. This Code applies to the following building services, except as excluded in para. 900.1.3: (1) water and antifreeze solutions for heating and cooling (2) condensing water (3) steam or other condensate (4) other nontoxic liquids (5) steam (6) vacuum (7) compressed air (8) other nontoxic, nonflammable gases (9) combustible liquids including fuel oil

(b) Boiler External Piping. The scope of this Code includes boiler external piping within the following limits: (1) for steam boilers, 15 psig (103 kPag) max; (2) for water heating units, 160 psig (1,103 kPag) max and 250°F (121°C) max. Boiler external piping above these pressure or temperature limits is within the scope of ASME B31.1.

(c) Material and Size Limits. Piping systems of the following materials are within the scope of this Code, through the indicated maximum size (and wall thickness if noted): (1) carbon steel: NPS 48 (DN 1,200) and 0.50 in. (12.7 mm) wall (2) stainless steel: NPS 24 (DN 600) and 0.50 in. (12.7 mm) wall (3) aluminum: NPS 12 (DN 300) (4) brass and copper: NPS 12 (DN 300) and 12.125 in. (308 mm) O.D. for copper tubing (5) thermoplastics: NPS 24 (DN 600) (6) ductile iron: NPS 48 (DN 1,200) (7) reinforced thermosetting resin: 24 in. (600 mm) nominal Other materials may be used as noted in Chapter III.

(d) Pressure Limits. Piping systems with working pressures not in excess of the following limits are within the scope of this Code:

(1) steam and condensate: 150 psig (1,034 kPag)

(2) liquids: 350 psig (2,413 kPag)

(3) vacuum: 1 atm external pressure

(4) compressed air and gas: 150 psig (1,034 kPag)

(e) Temperature Limits. Piping systems with working temperatures not in excess of the following limits are within the scope of this Code: (1) steam and condensate: 366°F (186°C); (2) other gases and vapors: 200°F (93°C) ; (3) other nonflammable liquids: 250°F (121°C). The minimum temperature for all services is 0°F (−18°C).

900.1.3 Exclusions. This Code does not apply to economizers, heaters, pumps, tanks, heat exchangers, and equipment covered by the ASME Boiler and Pressure Vessel (BPV) Code.

B31.11 Slurry Transportation Piping Systems

LANL does not apply this code because there are no know systems that are within the scope of the code.

Rules for this Code section have been developed considering the needs for applications, which include piping transporting aqueous slurries between plants and terminals and within terminals, pumping and regulating stations.

This Code does not apply to piping designed for internal pressures at or below 15 psig regardless of temperature or above 15 psig if the temperature is below -20°F (-30°C) or above 250°F (120°C).

B31.12 Hydrogen Piping and Pipelines

IP (industrial piping) Rules for this Part have been developed for hydrogen service included in petroleum refineries, refueling stations, chemical plants, power generation plants, semiconductor plants, cryogenic plants, hydrogen fuel appliances, and related facilities.

PL (pipelines) excludes the following: (a) design and manufacture of pressure vessels covered by the ASME Boiler and Pressure Vessel Code; (b) pipeline systems with temperatures above 450°F or below −80°F; (c) pipeline systems with pressures above 3000 psig; (d) pipeline systems with a moisture content greater than 20 ppm (dew point at 1 atm p −67°F); (e) pipeline systems with a hydrogen content less than 10% by volume.

B31.G Manual for Determining Remaining Strength of Corroded Pipelines

This document is intended solely for the purpose of providing guidance in the evaluation of metal loss in pressurized pipelines and piping systems. It is applicable to all pipelines and piping systems within the scope of the transportation pipeline codes that are part of ASME B31 Code for Pressure Piping, namely: ASME B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.11, Slurry Transportation Piping Systems; and ASME B31.12, Hydrogen Piping and Pipelines, Part PL. Where the term *pipeline* is used, it may also be read to apply to piping or pipe conforming to the acceptable applications and within the technical limitations discussed below.

49 CFR Part 192 Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

Note: These systems are also be required to B31.8

This part prescribes minimum safety requirements for pipeline facilities and the transportation of gas, including pipeline facilities and the transportation of gas within the limits of the outer continental shelf.

(b) This part does not apply to offshore gathering of gas in State waters; pipelines on the Outer Continental Shelf (OCS); onshore gathering of gas through a pipeline that operates at less than 0 psig, through a pipeline that is not a regulated onshore gathering line, and within inlets of the Gulf of Mexico; any petroleum gas or petroleum gas/air mixtures only pipeline to fewer than 10 customers, if no portion of the system is located in a public place; or a single customer, if the system is located entirely on the customer's premises (no matter if a portion of the system is located in a public place).

Attachment ASME - 1 – Code and Regulation Application

NFPA 54 National Fuel Gas Code

Note: NFPA systems are not required to meet ESM Chapter 17 and are presented here only for information to the reader to help clarify which codes apply to the different portions of natural gas systems.

1.1 Scope.

1.1.1 Applicability.

1.1.1.1 This code is a safety code that shall apply to the installation of fuel gas piping systems, appliances, equipment, and related accessories as shown in 1.1.1.1(A) through 1.1.1.1(D).

(A) Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be considered to be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators, in the system.

(B) The maximum operating pressure shall be 125 psi (862 kPa).

Exception No. 1: Piping systems for gas–air mixtures within the flammable range are limited to a maximum pressure of 10 psi (69 kPa).

Exception No. 2: LP-Gas piping systems are limited to 20 psi

(140 kPa), except as provided in 5.5.2.

(C) Requirements for piping systems shall include design, materials, components, fabrication, assembly, installation, testing, inspection, operation, and maintenance.

(D) Requirements for appliances, equipment, and related accessories shall include installation, combustion, and ventilation air and venting.

1.1.1.2 This code shall not apply to the following items (reference standards for some of which appear in Annex M):

(1) Portable LP-Gas appliances and equipment of all types that are not connected to a fixed fuel piping system

(2) Installation of farm appliances and equipment such as brooders, dehydrators, dryers, and irrigation equipment

(3) Raw material (feedstock) applications except for piping to special atmosphere generators

(4) Oxygen–fuel gas cutting and welding systems

(5) Industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen

(6) Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants

(7) Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions

(8) LP-Gas installations at utility gas plants

(9) Liquefied natural gas (LNG) installations

(10) Fuel gas piping in electric utility power plants

(11) Proprietary items of equipment, apparatus, or instruments such as gas generating sets, compressors, and calorimeters

(12) LP-Gas equipment for vaporization, gas mixing, and gas manufacturing

(13) LP-Gas piping for buildings under construction or renovations that is not to become part of the permanent building piping system -- that is, temporary fixed piping for building heat

(14) Installation of LP-Gas systems for railroad switch heating

(15) Installation of LP-Gas and compressed natural gas (CNG) systems on vehicles

(16) Gas piping, meters, gas pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas

(17) Building design and construction, except as

Attachment ASME - 1 – Code and Regulation Application

specified herein

(18) Fuel gas systems on recreational vehicles manufactured in accordance with NFPA 1192, *Standard on Recreational Vehicles*

(19) Fuel gas systems using hydrogen as a fuel

(20) Construction of appliances

1.1.2 Other Standards. In applying this code, reference shall also be made to the manufacturers' instructions and the serving gas supplier regulations.

1.2 Purpose. (Reserved)

1.3 Retroactivity. Unless otherwise stated, the provisions of this code shall not be applied retroactively to existing systems that were in compliance with the provisions of the code in effect at the time of installation.

1.4 Equivalency. The provisions of this code are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this code, provided any such alternative is acceptable to the authority having jurisdiction *(see 3.2.2).* The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternatives.

1.5 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority.

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This attachment defines fluid services designated as Category M at LANL per ASME B31.3 Process Piping[1]. It also defines lethal substances for LANL per B&PV Code Section VIII[2].

1. No designation in the right-hand column indicates the chemical is considered non-toxic/non-lethal, but no listing cannot be taken to mean that -- only that the chemical requires written evaluation/determination by the PSO and user and (with assistance of Industrial Hygiene if appropriate) with email notification to the CPSO.[3]
2. ID shown is not necessarily the operating system or system ID per ESM Chapter 1 Section 210.
3. Listings are generally alphabetically by media column.

[1] See ASME B31.3 paragraph 300.2 Definitions for "Fluid Service"
[2] See ASME B&PV Code Section VIII UW-2 paragraph (a) and footnote 1
[3] Notification to CPSO allows CPSO to oversee field decisions and/or add new chemicals to this listing over time

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
AC	acetylene	
AW	acid waste	**Yes** (for concentrated solutions)
AG	argon	
AK	HCFC – 225g (cleaning fluid)	
AM	ammonia	
AAM	anhydrous ammonia	**Yes**
AR	air	
AZ	aerozine 50 fuel	**Yes**
AN	aluminum nitrate	
BA	breathing air	
BH	biological hazard (deadly)	**Yes**
BF	boiler feed water	
BFB	bromofluorobenze	
CF4	carbon tetrafluoride	
CG	calibration gas	Depends on the test gas
ChB	chlorobenzene	
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	**Yes**
CL	chlorine gas	**Yes**
CO2	carbon dioxide	
CO	carbon monoxide	
CF4	carbon tetra fluoride	
CW	chilled water	
CA	compressed air	
CD	condensate pump discharge	
DB	diborane (2%), argon bal	**Yes**
DE	diesel	

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
DI	deionized water (incl. supply and return)	
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	**Yes**
FCB	fluorochlorobenzen	
FE	HFE – 7100 (cleaning fluid)	
FR	Freon (r12) dichlorodifluoromethane	
FU	monomethylhydrazine (MMH) fuel	**Yes**
FX	fire protection water	
GH	gaseous hydrogen	
GN	gaseous nitrogen	
GO	gaseous oxygen	
GS	gasoline	
HA	Halon fire suppression	
H2S	hydrogen sulfide	**Yes**
HAN	hydroxylamine nitrate	**Yes**
HWR	heating water return	
HWS	heating water supply	
HPS	high pressure steam (above 15 psig)	
HIB	hydroxyisobutyric acid	
HCl	hydrochloric acid	**Yes**
HC	hydrocarbon liquid	
HD	hydraulic fluid	Depends on the material reference MSDS
HE	gaseous helium	
HF	hydrogen fluoride	**Yes**

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
HFa	hydrofluoric acid	**Yes**
HL	liquid helium	
HCL	hydrogen chloride gas	**Yes**
HP	hydrogen peroxide (H_2O_2)	
HR	hydrofluoroether	
HW	hot water	
HY	hydrazine fuel	**Yes**
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 heat transfer fluid	
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	**Yes**
MA	methyl alcohol	
ME	methane	
MF	Freon MF solvent	
NA	sodium hydroxide (NaOH)	**Yes** (for concentrated solutions)
NG	natural gas	
NP	neopentane (2,2-dimethylpropane)	No

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
NWR	negative-pressure circulating chilled water return	
NWS	negative-pressure circulating chilled water supply	
NE	neon	
NAc	nitric acid	**Yes** (for concentrated solutions)
NO	nitric oxide	
NO2	nitrogen dioxide	**Yes**
N20	nitrous oxide	
N204	dinitrogen tetroxide (N_2O_4)	**Yes**
OL	oil	
P-10	P-10 gas mix	
PH3	phosphine	**Yes**
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	
SS	sanitary sewer	
SP	sump pump discharge	
SF	sulfur hexafluoride (SF6)	
SO2	sulfur dioxide	**Yes**
H2SO4	sulfuric acid	**Yes** (for concentrated

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
		solutions)
ST	steam	
TF	Freon TF solvent	
TG	test gas (special types, mixes, etc.)	**Depends on the test gas**
TMA	trimethylamine 108 ppm	
TWD	tower water drain	
TWR	tower water return	
TWS	tower water supply	
TW	treated water	

ID	Media (generally sorted by this)	Cat M/Lethal? (blank = no, missing = TBD)
T3	tritium	
UD	unsymmetrical dimethyl hydrazine (UDMH) fuel	**Yes**
VA	vacuum	
VH	vent header (to TA-55 zone 1 HVAC)	
WV	wet vacuum	
WA	water	
Z1	zone 1 (TA-55 HVAC)	

Flexhose and Relief Device Restraint

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	Pressure Safety POC and Committee

This document is online at http://engstandards.lanl.gov

Purpose: This document provides a listing of approved flexhose restraints and one acceptable method/example for designer approval of alternative flex hose restraint by determining thrust load. This same method can be used for thrust load determination of relief devices or their outlet piping to be used as an input to design of their supports.

Approved Flex Hose Restraints

Note: Self-restraining flexhoses like Air Liquide's LifeGuard Safety Hose Anti-Whip Internal Safety System and Global Passive Safety System's LifeGuard meet the requirement for restraint.[1]

Parker Hannifin flex hose restraints provide acceptable protection against whipping in the event of flex hose failure (most commonly shear at the fitting) up to the size/pressure values listed in the table below. For all other hoses, the designer is responsible to evaluate the material of construction and the anchor location to ensure the alternative is a safe design based on a thrust load calculation like the one later in this document.

Per the Parker Hose Whip Restraint Bulletin 4480-148 © 2009 Parker Hannifin Corp: "The Whip Restraint System has been tested to the operating pressures of the hoses listed in HPD Catalog 4400."

The HPD Catalog 4400 © 2011 Parker Hannifin Corporation has multiple types of hoses listed. The highest rating for a given size is shown below in Table ASME-4-1-1.

Table ASME-4-1-1: Highest Hose Ratings listed in Catalog 4400

Hose Size Designation	Hose Size (inch)	Highest Hose Rating	Hose Type
-4	¼	10,500	Hydraulic JK
-5	5/16	5,000	Hydraulic 302
-6	3/8	10,000	Hydraulic JK

[1] VAR-2013-064

-8	½	6,000	Constant Working Pressure 797TC
-10	5/8	6,000	Constant Working Pressure 797TC
-12	¾	6,000	Constant Working Pressure 797TC
-16	1	6,000	Constant Working Pressure 797TC
s-20	1 ¼	6,000	Constant Working Pressure 797TC
-24	2	6,000	Constant Working Pressure 791TC
-32	2 ½	5,000	Constant Working Pressure P35
-40	3 1/4	350	Transportation 201
-48	4	200	Transportation 201

Thus, the Parker Hose Whip Restraint may be used to the maximum value as shown in HPD Catalog 4400.

Designer approval of alternative flex hose restraints and design of relief device and outlet piping supports by calculating the conservative case thrust model

The example below is for a full gas cylinder at 2265 psig.

Estimating the initial surge thrust from an open line based on the assumption that the gas is exiting at sonic velocity, the mass flow rate results from the initial (pre-flow) density and sonic velocity, and that the pressures at the outlet of the tube has decrease to the highest pressure that maintains sonic flow (the critical pressure ratio). This is a worst-case condition and would probably only last a very short time duration until line losses resulted in a decrease in the mass flow and outlet pressure. In addition, the gas temperature will decrease due to isentropic expansion.

Reference: *Introductory Gas Dynamics*, Chapman and Walker, 1971 Ed. Page 273 Equation 7.7

$T = m' V + P_o A$ where:

m' mass flow rate

V' gas outlet velocity

P_o outlet pressure

A Area of the outlet

$m' = rho/g\ v_s A$ mass flow rate based on upstream density (rho), sonic velocity (v_s), and inside diameter

rho = P/RT density based on ideal gas behavior

P absolute pressure

R Gas Constant

T absolute temperature

$V = v_s$ outlet gas velocity is sonic velocity

$V_s = (k\ g\ R\ T)^{1/2}$ sonic velocity for an ideal gas, where:

k ratio of specific heats

g acceleration due to gravity

$P_o = P/PR_c$ outlet pressure based on upstream pressure and critical pressure ratio

critical pressure ratio, reference *Orifice Meters With Supercritical Compressible Flow*, Cunningham, page 635, formula 20, inverse of formula used for upstream to downstream pressure

$PR_c = [(k + 1)/2]^{(k/(k-1))}$

General Thrust Equation: $F = m_e\ w - m_i\ V_o + (P_e - P_o)\ A_e$, where

F = Thrust

m_e = Exit Mass Flow Rate

w = Velocity of exit gas

m_i = Inlet mass flow rate

V_o =Velocity of Free-Stream Air (flight speed)

P_e = Absolute Static Pressure in Exit Section of Exhaust Nozzle

P_o = Absolute Static Pressure of Free-Stream Ambient

A_e = Cross-Sectional Area of Exit Section of Exhaust Nozzle

Solving for thrust:

$T_s = [(P/(RTg))\ ((k\ g\ R\ T)^{1/2})\ A\ ]\ ((k\ g\ R\ T)^{1/2}) + [P/[((k+1)/2)^{(k/(k-1))}]\ A$

Simplifying the equation:

$T_s = PA\ \{k + 1/[((k+1)/2)^{(k/(k-1))}]\}$

Defining the value within the bracket as the Surge Thrust Factor (STF):

$T_s = PA\ STF$

Example: Surge thrust forces for various flex hose sizes with argon with a maximum internal pressure of 2265 psig:

k (argon) = 1.67

Rc (Critical Pressure Ratio) = 2.05

STF (argon) = 2.16 (bounding condition)

Result:

Table ASME 4-1-2 Calculated Surge Thrust (example, argon @ 2265 psig)

Flex Hose ID (fractional inch)	Flex Hose ID (decimal inch)	Area (Pi*D^2/4)	Argon Surge Thrust Factor	Surge Thrust (lbf)
1/8"	0.125	0.0123	2.16	60
1/4"	0.25	0.0491	2.16	240
5/16"	0.3125	0.0767	2.16	375
3/8"	0.375	0.1104	2.16	540
7/16"	0.4375	0.1503	2.16	735
1/2"	0.5	0.1963	2.16	961
9/16"	0.5625	0.2485	2.16	1216
5/8"	0.625	0.3068	2.16	1501
11/16"	0.6875	0.3712	2.16	1816
3/4"	0.75	0.4418	2.16	2161
7/8"	0.875	0.6013	2.16	2942
1"	1	0.7854	2.16	3842
1 1/4"	1.25	1.2272	2.16	6004
1 1/2"	1.5	1.7671	2.16	8646
1 3/4"	1.75	2.4053	2.16	11768
2"	2	3.1416	2.16	15370
2 1/4"	2.25	3.9761	2.16	19453
2 1/2"	2.5	4.9087	2.16	24016
2 3/4"	2.75	5.9396	2.16	29059
3"	3	7.0686	2.16	34582
3 1/4"	3.25	8.2958	2.16	40586
3 1/2"	3.5	9.6211	2.16	47070
3 3/4	3.75	11.0447	2.16	54035
4"	4	12.5664	2.16	61480

Brackets, supports, hose restraints, or whip restraints must be designed to meet or exceed the surge thrust calculated.

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This document provides a listing of available Swagelok hose and flexible tubing styles and associated data[1] and indicates whether each is acceptable for code construction at LANL when used within its limits.

[1] Swagelok information taken from publication MS-01-180, May 2011 R5. 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.

Swagelok Flex Hose Series	ASME B31.3 Piping Component?	ASME B31.3-2010 Component Standard	Manufacturer Ratings Based on Code	Burst Pressure and Pressure Ratings as a Function of Temperature	Single Burst Test	No Burst Test	LANL-Wide Approval?	Additional Requirements
FM	Yes	BS 6501, Part 1	B31.1	No	NA	NA	Yes	None
FJ	Yes	BS 6501, Part 1	B31.3	No	NA	NA	Yes	None
FL	Yes	BS 6501, Part 1	B31.1	No	NA	NA	Yes	None
CT	Yes	BS 6501, Part 1	None	No	NA	Yes	**No**	See A323.2
T	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
B	Yes	ASTM F423	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
X	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
S	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
C	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2

Swagelok Flex Hose Series	ASME B31.3 Piping Component?	ASME B31.3-2010 Component Standard	Manufacturer Ratings Based on Code	Burst Pressure and Pressure Ratings as a Function of Temperature	Single Burst Test	No Burst Test	LANL-Wide Approval?	Additional Requirements
N	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
W	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
F	Yes	ASTM F423	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
U	Yes	F781	None	Yes	NA	NA	Yes	MAWP based on temperature see A323.2
PFA	Yes	F781	None	No	NA	Yes	**No**	See A323.2
LT	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
NG	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
7R	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
8R	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
7N	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
8N	Yes	Unlisted	None	No	Yes	NA	**No**	See A323.2 and A323.2.4

Swagelok Flex Hose Series	ASME B31.3 Piping Component?	ASME B31.3-2010 Component Standard	Manufacturer Ratings Based on Code	Burst Pressure and Pressure Ratings as a Function of Temperature	Single Burst Test	No Burst Test	LANL-Wide Approval?	Additional Requirements
7P	Yes	ASTM D2737	None	No	Yes	NA	**No**	See A323.2 and A323.2.4
PB	Yes	Unlisted	None	Yes	NA	NA	**No**	See A323.2 and A323.2.4

Some Consensus Standards on Flex Hoses (guidance)

88.	Order	**ASTM F423** Superseded by: NO REPLACEMENT Details | History	Withdrawn	1995.09.10	Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges	Favorites (Add) Watch List (Add
27.	Order	**ASTM F781** Superseded by: NO REPLACEMENT **Details | History**	Withdrawn	1995.01.01	Standard Specification for Perfluoro (Alkoxyalkane) Copolymer (PFA) Plastic-Lined Ferrous Metal Pipe and Fittings	Favorites (Add) Watch List (Add)
6.	Order	**BSI BS 6501-1** **Partially superseded by: BSI BS EN ISO 10380** **Details | History**	Active	2004.02.19 (R 2009)	Metal hose assemblies - Part 1: Guidance on the construction and use of corrugated hose assemblies	Favorites (Add) Watch List (Add)

Conduct of Engineering
Request for Variance or Alternate Method

Assigned by SMPO or SMPOR: ☒ Alternate Method ☐ Variance Tracking number VAR- 2015-011

1.0 Affected Document(s)

☐ Engineering Processes (e.g., P 341) ☒ Engineering Standards (e.g., P 342) ☐ Engineering Training & Qualification (e.g., P 343) If against P documents themselves, revision: ______	Subordinate (Functional Series) document if applicable (ESM Chapter, Master Spec, AP, etc.): Document Title/Number: ESM Chapter 17 *Pressure Safety, ASME* Revision: 0 Document Title/Number: Engineering Standards Manual STD-342-001 Revision: 0

Section/Para

Section ASME-R0

"1.0 NEW FABRICATION

All boilers, pressure vessels, air receivers, and supporting piping shall meet the appropriate ASME Boiler and Pressure Vessel Code Section, and B31 piping section as applicable."

Section REF-3 ASME B31.3 Process Piping Guide
Piping Specifications 400, 401, 402, 403, and 404

Specific Requirement(s) as Written in the Document(s)

For new construction to ASME B31.3-2012, B31.5-2013, and B31.9-2011 require the use of listed items or unlisted items with alternative evaluations.

ASME B31.3-2012

> **326.1.2 Unlisted Piping Components.** Piping components not listed in Table 326.1 or Appendix A shall meet the pressure design requirements described in para. 302.2.3 and the mechanical strength requirements described in para. 302.5.

ASME B31.5-2013

> **526.2 Nonstandard Piping Components**
> The dimensions for nonstandard piping components shall, where possible, provide strength and performance equivalent to standard components, except as permitted under section 504. For convenience, dimensions shall conform to those of comparable standard components.

ASME B31.9-2011

926.3 Nonstandard Piping Components

When nonstandard piping components are used, pressure design shall be in accordance with para. 904. Adherence to the dimensional principles in American National Standards referenced in Table 926.1 is recommended to the greatest practicable extent.

2.0 Request

Brief descriptive title:

Accepting and limiting the use of Mueller/Streamline "Standard Tube" copper for LANL pressure systems.

NCR required (work has occurred)? ☐ Yes ☐ No	If Yes, NCR Number
TA-Bldg-(Room) and/or Project Affected LANL	System/Component Affected

Proposal

LANL has developed a table showing the lowest rated item including copper tube, copper fittings, and solder joint rating based on size. These tables will be used as the bounding condition for the maximum allowable working pressure for a system using these items.

Justification/Compensatory Measures

Mueller/Streamline states in their March 11, 2011 letter they meet the material requirements of ASTM B88 and B280. However the document continues and the "Standard Tube" product is not guaranteed to have the dimensional (minimum wall thickness) required by ASTM B88 or B280. Mueller/Streamline produced another letter dated April 17, 2012 that their product is UL tested and meets operating pressures of 700 psi at 250 ^{o}F.

The wall thicknesses of UL 207 and UL 1963 are less than the minimums allowed by ASTM B88 or B280. This evaluation is applicable for the tubing with a specified minimum in accordance with the UL 207 and UL 1963.

The ASME B31 codes allow for other calculations to be performed so that in this case the thin walled copper tubing supplied by Mueller/Streamline is evaluated and a definitive range allow.

ASME B31.3-2012

300 GENERAL STATEMENTS

(c) Intent of the Code

(3) Engineering requirements of this Code, while considered necessary and adequate for safe design, generally employ a simplified approach to the subject. A designer capable of applying a more rigorous analysis shall have the latitude to do so; however, the approach must be documented in the engineering design and its validity accepted by the owner. The approach used shall provide details of design, construction, examination, inspection, and testing for the design conditions of para. 301, with calculations consistent with the design criteria of this Code.

ASME B31.5-2013

INTRODUCTION

The Code sets forth engineering requirements deemed necessary for safe design and construction of refrigeration,

heat transfer components, and secondary coolant
piping systems. While safety is the basic consideration
of this Code, this factor alone will not necessarily govern
the final specifications for any pressure piping system.
The designer is cautioned that the Code is not a design
handbook. The Code does not eliminate the need for
the designer or competent engineering judgment.

ASME B31.9-2011

900 GENERAL

Engineering requirements of this Code, while considered
necessary and adequate for safe design, generally
employ a simplified approach. An engineer capable of
applying a more rigorous analysis shall have the latitude
to do so. He must be able to demonstrate the validity
of his approach.

Assumptions

Copper tubing meets ASTM B88-2009 or ASTM B280-2013 material requirements.
Copper that is soldered will be considered annealed.
Corrosion allowance is zero.

Basis

The allowable stress for annealed copper is 6000 psi at 100 ^{o}F.
The allowable stress for annealed copper is 5100 psi at 150 ^{o}F.

Calculation

B31.3, B31.5, B31.9 (reference to B31.1), B16.18, and B16.22 all use the equation for rating tube as:

$P = 2\ S\ t\ /\ (D - .8t)$

P = allowable pressure, psi
S = maximum allowable stress in tension, psi
t_{min} = wall thickness (min.), in.
D_{max} = outside diameter (max.), in.

Example for UL207 annealed copper.

S = 6000 psi
D_{max} = 0.377 in
t_{min} = 0.0265 in (from UL 203 or 1963)

$P = (2 * 6000 * 0.0265)/ (.377 – 0.8 * 0.0265)$

P = 894 psi

The UL 207 and UL 1963 do not duplicate the entire range of ASTM B88 or B280.

At 100 ^{o}F the annealed copper tubing using the allowable thicknesses from the UL 207 and UL 1963 controls three occurrences (see highlighted table cells below). In any case, the **lowest** rated item either the tubing/fitting or the solder joint size would controls the maximum allowable pressure at either 100 or 150 ^{o}F.

Maximum Allowable Pressures in Copper at 100 °F

Nominal Stardard Size (in)	Outside Diameter (in)	Lowest Rating from Fitting or Tube (psig)	Joint Rating (psig)			
			Solder Alloy Sn 50	Alloy Solder 95-5	Solder Alloy E	Solder Alloy HB
0.25	0.3750	894	200	1090	710	1035
0.375	0.5000	714	200	1090	710	1035
0.5	0.6250	628	200	1090	710	1035
0.625	0.7500	630	200	1090	710	1035
0.75	0.8750	580	200	1090	710	1035
1	1.1250	490	200	1090	710	1035
1.25	1.3750	435	175	850	555	805
1.5	1.6250	405	175	850	555	805
2	2.125	360	175	850	555	805
2.5	2.625	335	150	705	460	670

Maximum Allowable Pressures in Copper at 150 °F

Nominal Stardard Size (in)	Outside Diameter (in)	Lowest Rating from Fitting or Tube (psig)	Joint Rating (psig)			
			Solder Alloy Sn 50	Alloy Solder 95-5	Solder Alloy E	Solder Alloy HB
0.25	0.3750	760	150	625	475	710
0.375	0.5000	607	150	625	475	710
0.5	0.6250	534	150	625	475	710
0.625	0.7500	535	150	625	475	710
0.75	0.8750	490	150	625	475	710
1	1.1250	420	150	625	475	710
1.25	1.3750	370	125	485	370	555
1.5	1.6250	345	125	485	370	555
2	2.125	305	125	485	370	555
2.5	2.625	285	100	405	305	460

Summary: The “Standard Tube” provided by Mueller/Streamline may be used for B31.3, B31.5, B31.9 construction as long as the pressure ratings of the copper systems are less than the Lowest Rating from Fitting or Tube (psig) or the Joint Rating when using a value that is less, that is the Solder Allow Sn 50.

Similar comparison for other tubing dimensions and other temperature ranges must be performed by the design engineer for the specific case.

Attachments:
ASTM B88-2009 (page 3, Table 1)
ASTM B280-2013 (page 2 Table 1, page 3 Table 2)
ASME B16.18-12 (page 6 Table 1, page 46 Table A-1, page 47 wall thickness equation)

ASME B16.22-2012 (page 12 Table II-2, page 13 Table II-4, page 15 wall thickness equation)
UL 207-2009 (page 12, Table 5.1)
UL 1963-2012 (page 75, Table 46.1)
UL Mueller/Streamline
Mueller letter dated March 11, 2011
Mueller letter dated April 17, 2012
ASME B31.3-2012 (page 20 304.1.2 wall thickness equation, pages 184, 185 allowable stress)
ASME B31.5-2013 (page 24; 504.1.2 wall thickness equation, pages 14, 15 allowable stress)
ASME B31.9-2010 (page 12 904.1.1 reference to allow use of B31.1 equations, page 51 allowable stress)
ASME B31.1-2012 (page 19, 20, 21 104.1.2 wall thickness equation)
Section REF-3 ASME B31.3 Process Piping Guide: Piping Specifications 400, 401, 402, 403, and 404

Duration of Request: (Lifetime)	Start Date: 11/13/14		End Date: NA		☒ Lifetime
Requestor Ari Ben Swartz		Z Number 235211	Organization ES-EPD	Signature Signature on file	Date 11/13/14
USQD/USID required (Nucl. High/Mod Hazard)? ☐ Yes ☒ No			If Yes, USQD/USID Number		
Design Authority Representative Lawrence Kenneth Goen		Z Number 106351	Organization ES-DO	Signature Signature on file	Date 11/24/14
LANL Owning Manager (FOD or Programmatic) Lawrence Kenneth Goen		Z Number 106351	Organization ES-DO	Signature Signature on file	Date 11/24/14

3.0 Safety Management Program Owner (SMPO) Representative (SMPOR/POC)

☐ Decline ☒ Accept ☐ Accept Labwide ☐ with Modification:			
POC Ari Ben Swartz	Z Number 235211	Signature Signature on file	Date 11/13/14

4.0 Additional Approval for P341 and APs; P342, ESM, Code, and Regulation Matters; and P343

☒ Accepted ☐ Accepted with comments ☐ Declined			
Comments:			
Safety or Security Management Program Owner Lawrence Kenneth Goen	Z Number 106351	Signature Signature on file	Date 11/24/14

TABLE 1 Dimensions, Weights, and Tolerances in Diameter and Wall Thickness for Nominal or Standard Copper Water Tube Sizes
(All tolerances are plus and minus except as otherwise indicated)

Nominal or Standard Size, in.	Outside Diameter, in.	Average Outside Diameter[A] Tolerance, in.		Wall Thickness and Tolerances, in.						Theoretical Weight, lb/ft		
				Type K		Type L		Type M				
		Annealed	Drawn	Wall Thickness	Toler-ance[B]	Wall Thickness	Toler-ance[B]	Wall Thickness	Toler-ance[B]	Type K	Type L	Type M
¼	0.375	0.002	0.001	0.035	0.0035	0.030	0.003	[C]	[C]	0.145	0.126	[C]
⅜	0.500	0.0025	0.001	0.049	0.005	0.035	0.004	0.025	0.002	0.269	0.198	0.145
½	0.625	0.0025	0.001	0.049	0.005	0.040	0.004	0.028	0.003	0.344	0.285	0.204
⅝	0.750	0.0025	0.001	0.049	0.005	0.042	0.004	[C]	[C]	0.418	0.362	[C]
¾	0.875	0.003	0.001	0.065	0.006	0.045	0.004	0.032	0.003	0.641	0.455	0.328
1	1.125	0.0035	0.0015	0.065	0.006	0.050	0.005	0.035	0.004	0.839	0.655	0.465
1¼	1.375	0.004	0.0015	0.065	0.006	0.055	0.006	0.042	0.004	1.04	0.884	0.682
1½	1.625	0.0045	0.002	0.072	0.007	0.060	0.006	0.049	0.005	1.36	1.14	0.940
2	2.125	0.005	0.002	0.083	0.008	0.070	0.007	0.058	0.006	2.06	1.75	1.46
2½	2.625	0.005	0.002	0.095	0.010	0.080	0.008	0.065	0.006	2.93	2.48	2.03
3	3.125	0.005	0.002	0.109	0.011	0.090	0.009	0.072	0.007	4.00	3.33	2.68
3½	3.625	0.005	0.002	0.120	0.012	0.100	0.010	0.083	0.008	5.12	4.29	3.58
4	4.125	0.005	0.002	0.134	0.013	0.110	0.011	0.095	0.010	6.51	5.38	4.66
5	5.125	0.005	0.002	0.160	0.016	0.125	0.012	0.109	0.011	9.67	7.61	6.66
6	6.125	0.005	0.002	0.192	0.019	0.140	0.014	0.122	0.012	13.9	10.2	8.92
8	8.125	0.006	+ 0.002 −0.004	0.271	0.027	0.200	0.020	0.170	0.017	25.9	19.3	16.5
10	10.125	0.008	+ 0.002 −0.006	0.338	0.034	0.250	0.025	0.212	0.021	40.3	30.1	25.6
12	12.125	0.008	+ 0.002 −0.006	0.405	0.040	0.280	0.028	0.254	0.025	57.8	40.4	36.7

[A] The average outside diameter of a tube is the average of the maximum and minimum outside diameter, as determined at any one cross section of the tube.
[B] Maximum deviation at any one point.
[C] Indicates that the material is not generally available or that no tolerance has been established.

TABLE 2 Chemical Composition—Weight %

Element	Copper UNS No.		
	C10200[A]	C12000	C12200
Copper,[B] min	99.95	99.90	99.9
Phosphorus	...	0.004–0.012	0.015–0.040

[A] Oxygen shall be 10 ppm max.
[B] Copper + silver.

8. Mechanical Property Requirements

8.1 The tube shall conform to the mechanical property requirements prescribed in Table 3. Tension tests and grainsize determinations need not be made except when indicated by the purchaser at the time of placing the order. A convenient method of indicating that these tests are to be made is to state that "Test Procedure 'T' is required" (see 4.2.1). Where agreement on the Rockwell hardness tests cannot be reached, the tensile strength and grain-size requirements of Table 3 shall be the basis for acceptance or rejection.

9. Performance Requirements

9.1 *Expansion Test*:

9.1.1 The annealed (O) tube shall be capable of being expanded in accordance with Test Method B153 with an expansion of the outside diameter in the following amount:

Nominal or Standard Size, in.	Expansion of Outside Diameter, %
⅝ and under	40
Over ⅝	30

The expanded tube shall show no cracking or rupture visible to the unaided eye.

9.2 *Flattening Test*:

9.2.1 As an alternative to the expansion test for tube standard sizes 4 in. and over in the annealed condition, a section 4 in. in length shall be cut from the end of one of the lengths for a flattening test. This 4-in. test specimen shall be flattened so that a gage set at three times the wall thickness will pass over the tube freely throughout the flattened part. The tube so tested shall develop no cracks or flaws visible to the unaided eye as a result of this test. In making the flattening test the elements shall be slowly flattened by one stroke of the press.

9.3 *Microscopical Examination for Susceptibility to Hydrogen Embrittlement*:

9.3.1 Tubes furnished in Copper UNS No. C10200 and C12000 shall be essentially free of cuprous oxide as determined by Procedure A of Test Methods B577. When Copper UNS No. C12200 is supplied, examination is not required. In case of a dispute, Procedure C of Test Methods B577 shall be used as the referee method.

9.3.2 Tubes furnished in all coppers shall be capable of passing the embrittlement test specified in Procedure B of Test Methods B577. The actual performance of the test is not required unless specifically requested in the ordering document. In case of a dispute, Procedure C of Test Methods B577 shall be used as the referee method.

10. Nondestructive Testing

10.1 Each tube up to and including 3⅛ in. in outside diameter shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice E243, except for the determination of "end effect." Tubes shall be passed through an eddy-current test unit adjusted to provide information on the suitability of the tube for the intended application.

10.1.1 Notch-depth standards, rounded to the nearest 0.001 in., shall be 22 % of the wall thickness. The notch-depth tolerance shall be plus and minus 0.0005 in. Alternatively, at

3. Terminology

3.1 *Definitions:*

3.1.1 *average diameter (for round tubes only), n*—the average of the maximum and minimum outside diameters, or maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

3.1.2 *bright anneal, n*—a thermal treatment carried out in a controlled atmosphere so that surface oxidation is reduced to a minimum and the surface remains relatively bright.

3.1.3 *coil, n*—a length of the product wound into a series of connected turns. The unqualified term "coil" as applied to tube usually refers to a bunched coil.

3.1.3.1 *bunched, n*—a coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.

3.1.3.2 *level or traverse wound, n*—a coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another. (Sometimes called "helical coil.")

3.1.3.3 *single layer flat, n*—a coil in which the product is spirally wound into a single disc-like layer. (Sometimes called "pancake coil" or "single layer spirally wound coil.")

3.1.3.4 *double layer flat, n*—a coil in which the product is spirally wound into two connected disc-like layers such that one layer is on top of the other. (Sometimes called "double layer pancake coil" or "double layer spirally wound coil.")

3.1.4 *lengths, n*—straight pieces of the product.

3.1.4.1 *specific, n*—straight lengths that are uniform in length, as specified, and subject to established length tolerances.

3.1.4.2 *standard, n*—uniform lengths recommended in a Simplified Practice Recommendation or established as a Commercial Standard.

3.1.5 *tube, seamless, n*—a tube produced with a continuous periphery in all stages of the operations.

3.1.5.1 *tube, air conditioning, n*—a seamless copper tube conforming to a standard series of sizes (Table 1) and to specified internal cleanness requirements, normally furnished in drawn temper straight lengths with the ends capped or sealed.

3.1.5.2 *tube, refrigeration service, n*—a seamless copper tube conforming to a standard series of sizes (Table 2) and to special internal cleanliness and dehydration requirements, normally furnished in soft temper coils and with ends capped or sealed.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *capable of*—the test need not be performed by the producer of the material. However, if subsequent testing by the purchaser establishes that the material does not meet these requirements, the material shall be subject to rejection.

4. Ordering Information

4.1 Include this information for contracts or purchase orders for products furnished to this specification:

4.1.1 ASTM designation and year of issue (for example, B280 – 03),

4.1.2 Copper UNS No. (not necessary unless a specific copper is desired),

4.1.3 Dimensions; wall thickness, diameter, and so forth (Section 13),

4.1.4 How furnished: coils or straight lengths,

4.1.5 Temper (for example, O60 or H58),

4.1.6 Size (Tables 1 and 2),

4.1.7 Length (Section 13),

4.1.8 Quantity (total pieces of each size and type),

4.1.9 When product purchased for agencies of the U.S. Government (Section 12).

4.2 The following options are available and shall be specified in the contract or purchase order when required:

4.2.1 Tensile test (Section 9),

4.2.2 Expansion test (Section 10.1),

4.2.3 Cleanness test (Sections 10.2 and 18.2.4),

TABLE 1 Standard Dimensions and Weights, and Tolerances in Diameter and Wall Thickness for Straight Lengths

NOTE 1—Applicable to drawn temper tube only.

Standard Size, in.	Outside Diameter, in. (mm)	Wall Thickness, in. (mm)	Weight, lb/ft (kg/m)	Tolerances: Average[A] Outside Diameter, Plus and Minus, in. (mm)	Tolerances: Wall [B] Thickness, Plus and Minus, in. (mm)
1/4	0.250 (6.35)	0.025 (0.635)	0.068 (0.102)	0.001 (0.025)	0.0025 (0.06)
3/8	0.375 (9.52)	0.030 (0.762)	0.126 (0.187)	0.001 (0.025)	0.003 (0.08)
1/2	0.500 (12.7)	0.035 (0.889)	0.198 (0.295)	0.001 (0.025)	0.004 (0.10)
5/8	0.625 (15.9)	0.040 (1.02)	0.285 (0.424)	0.001 (0.025)	0.004 (0.10)
3/4	0.750 (19.1)	0.042 (1.07)	0.362 (0.539)	0.001 (0.025)	0.004 (0.10)
7/8	0.875 (22.3)	0.045 (1.14)	0.455 (0.677)	0.001 (0.025)	0.004 (0.10)
1 1/8	1.125 (28.6)	0.050 (1.27)	0.655 (0.975)	0.0015 (0.038)	0.004 (0.10)
1 3/8	1.375 (34.9)	0.055 (1.40)	0.884 (1.32)	0.0015 (0.038)	0.006 (0.15)
1 5/8	1.625 (41.3)	0.060 (1.52)	1.14 (1.70)	0.002 (0.051)	0.006 (0.15)
2 1/8	2.125 (54.0)	0.070 (1.78)	1.75 (2.60)	0.002 (0.051)	0.007 (0.18)
2 5/8	2.625 (66.7)	0.080 (2.03)	2.48 (3.69)	0.002 (0.051)	0.008 (0.20)
3 1/8	3.125 (79.4)	0.090 (2.29)	3.33 (4.96)	0.002 (0.051)	0.009 (0.23)
3 5/8	3.625 (92.1)	0.100 (2.54)	4.29 (6.38)	0.002 (0.051)	0.010 (0.25)
4 1/8	4.125 (105)	0.110 (2.79)	5.38 (8.01)	0.002 (0.051)	0.011 (0.28)

[A] The average outside diameter of a tube is the average of the maximum and minimum outside diameters as determined at any one cross section of the tube.

[B] The tolerances listed represent the maximum deviation at any point.

TABLE 2 Standard Dimensions and Weights, and Tolerances in Diameter and Wall Thickness for Coil Lengths

Standard Size, in.	Outside Diameter, in. (mm)	Wall Thickness, in. (mm)	Weight, lb/ft (kg/m)	Tolerances	
				Average[A] Outside Diameter, Plus and Minus, in. (mm)	Wall[B] Thickness, Plus and Minus, in. (mm)
1/8	0.125 (3.18)	0.030 (0.762)	0.0347 (0.0516)	0.002 (0.051)	0.003 (0.08)
3/16	0.187 (4.75)	0.030 (0.762)	0.0575 (0.0856)	0.002 (0.051)	0.003 (0.08)
1/4	0.250 (6.35)	0.030 (0.762)	0.0804 (0.120)	0.002 (0.051)	0.003 (0.08)
5/16	0.312 (7.92)	0.032 (0.813)	0.109 (0.162)	0.002 (0.051)	0.003 (0.08)
3/8	0.375 (9.52)	0.032 (0.813)	0.134 (0.199)	0.002 (0.051)	0.003 (0.08)
1/2	0.500 (12.7)	0.032 (0.813)	0.182 (0.271)	0.002 (0.051)	0.003 (0.08)
5/8	0.625 (15.9)	0.035 (0.889)	0.251 (0.373)	0.002 (0.051)	0.004 (0.11)
3/4	0.750 (19.1)	0.035 (0.889)	0.305 (0.454)	0.0025 (0.064)	0.004 (0.11)
7/8	0.875 (22.3)	0.045 (1.14)	0.455 (0.677)	0.003 (0.076)	0.004 (0.11)
1 1/8	1.125 (28.6)	0.050 (1.27)	0.655 (0.975)	0.0035 (0.089)	0.005 (0.13)
1 3/8	1.375 (34.9)	0.055 (1.40)	0.884 (1.32)	0.004 (0.10)	0.006 (0.15)
1 5/8	1.625 (41.3)	0.060 (1.52)	1.14 (1.70)	0.0045 (0.11)	0.006 (0.15)

[A] The average outside diameter of a tube is the average of the maximum and minimum outside diameters as determined at any one cross section of the tube.
[B] The tolerances listed represent the maximum deviation at any point.

4.2.4 Microscopical Examination for Hydrogen Embrittlement, Procedure B (10.3.2),

4.2.5 Certification (Section 22), and

4.2.6 Test report (Section 23).

5. Materials and Manufacture

5.1 *Materials*—The material of manufacture shall be billets, bars, or tube and shall be of such soundness as to be suitable for processing into the tubular products described.

5.2 *Manufacture:*

5.2.1 The tube shall be manufactured by such hot or cold working processes as to produce a homogeneous uniform wrought structure in the finished product. The tube shall be cold drawn to the finished size and wall thickness.

5.2.2 Coiled lengths specified O60, soft annealed temper, shall be bright annealed after coiling, then dehydrated, and capped, plugged, crimped, or otherwise closed at both ends so as to maintain the internal cleanness of the tubing under normal conditions of handling and storage.

5.2.3 Straight lengths specified H58 hard-drawn temper shall be cleaned and capped, plugged, or otherwise closed at both ends so as to maintain the internal cleanness of the tubing under normal conditions of handling and storage.

6. Chemical Composition

6.1 The chemical composition shall conform to the chemical requirements in Table 3 for the specific type of copper.

6.1.1 These limits do not preclude the presence of other elements. When included in the contract or purchase order, and agreed upon by the manufacturer or supplier and the purchaser, limits shall be established and analysis required for unnamed elements.

TABLE 3 Chemical Composition—Weight %

Element	Copper UNS No.		
	C10200[A]	C12000	C12200
Copper,[B] min	99.95	99.90	99.9
Phosphorus	. . .	0.004–0.012	0.015–0.040

[A] Oxygen shall be 10 ppm max.
[B] Copper + silver.

7. Temper

7.1 Product under this specification shall be furnished in either O60 (soft annealed) or H58 (drawn general purpose) temper, as specified in the contract or purchase order and defined in Classification B601.

7.1.1 Coils are normally furnished in O60 temper and straight lengths in H58 temper.

8. Grain Size

8.1 Coiled lengths shall be furnished in the O60 temper and shall have a recrystallized grain size of 0.040 mm minimum when determined in accordance with Test Methods E112.

9. Tensile Requirements

9.1 The tube shall conform to the tensile requirements prescribed in Table 4.

9.2 Tensile tests need not be performed except when specified in the contract or purchase order.

10. Performance Requirements

10.1 *Expansion Test:*

10.1.1 Tube furnished in the O60 soft annealed temper shall be capable of being expanded in accordance with Test Method B153 to the following extent:

10.1.1.1 The expanded tube shall show no cracking or other defects visible to the unaided eye.

10.1.2 Unless specified in the contract or purchase order, this test is not required to be performed by the manufacturer.

10.2 *Cleanness of Interior Surface :*

TABLE 4 Tensile Requirements

Form	Temper Designation		Tensile Strength, min		Elongation in 2 in. (50.8 mm), min, %
	Standard	Former	ksi[A]	MPa[B]	
Coiled lengths	O60	soft annealed	30	205	40
Straight lengths	H58	drawn general purpose	36	250	. . .

[A] ksi = 1000 psi.
[B] See Appendix X1.

(12)

Table 1 Internal Pressure–Temperature Ratings for Cast Copper Alloy Fittings, psi (kPa)

Standard Water Tube Size	−20°F to 100°F (−29°C to 38°C)	150°F (66°C)	200°F (93°C)	250°F (121°C)	300°F (149°C)	350°F (177°C)	400°F (204°C)
1/4	910 (6 280)	770 (5 340)	745 (5 130)	725 (5 020)	710 (4 920)	605 (4 190)	455 (3 140)
3/8	775 (5 360)	660 (4 560)	635 (4 380)	620 (4 290)	610 (4 200)	515 (3 570)	385 (2 680)
1/2	720 (4 970)	610 (4 220)	585 (4 060)	575 (3 980)	565 (3 890)	480 (3 310)	360 (2 480)
5/8	630 (4 350)	535 (3 700)	515 (3 555)	505 (3 480)	490 (3 410)	420 (2 900)	315 (2 170)
3/4	580 (4 010)	490 (3 410)	475 (3 275)	465 (3 210)	455 (3 140)	385 (2 670)	290 (2 000)
1	490 (3 400)	420 (2 890)	400 (2 780)	395 (2 720)	385 (2 660)	325 (2 270)	245 (1 700)
1 1/4	435 (3 020)	370 (2 570)	355 (2 470)	350 (2 420)	340 (2 370)	290 (2 010)	215 (1 510)
1 1/2	405 (2 810)	345 (2 390)	330 (2 300)	325 (2 250)	315 (2 200)	270 (1 870)	200 (1 400)
2	360 (2 500)	305 (2 130)	295 (2 045)	290 (2 000)	280 (1 960)	240 (1 670)	180 (1 250)
2 1/2	335 (2 310)	285 (1 960)	270 (1 890)	265 (1 850)	260 (1 810)	220 (1 540)	165 (1 150)
3	315 (2 180)	265 (1 850)	255 (1 785)	250 (1 740)	245 (1 710)	210 (1 450)	155 (1 090)
3 1/2	300 (2 090)	255 (1 770)	245 (1 705)	240 (1 670)	235 (1 630)	200 (1 390)	150 (1 040)
4	290 (2 020)	245 (1 710)	240 (1 650)	230 (1 610)	225 (1 580)	195 (1 340)	145 (1 010)
5	265 (1 850)	225 (1 570)	220 (1 515)	215 (1 480)	210 (1 450)	175 (1 230)	130 (920)
6	250 (1 720)	210 (1 460)	205 (1 420)	200 (1 380)	195 (1 350)	165 (1 150)	125 (860)
8	270 (1 860)	225 (1 580)	220 (1 520)	215 (1 490)	210 (1 460)	180 (1 240)	135 (930)
10	270 (1 860)	230 (1 580)	220 (1 525)	215 (1 490)	210 (1 460)	180 (1 240)	135 (930)
12	250 (1 740)	215 (1 480)	205 (1 425)	200 (1 390)	195 (1 360)	165 (1 160)	125 (870)

GENERAL NOTES:
(a) For size designation of fittings, see section 4.
(b) The internal pressure rating applies to the largest opening of the fitting.
(c) The internal pressure rating is calculated, as shown in Nonmandatory Appendix B, then rounded down to the nearest unit of 5 for psi and 10 for kPa.

Table A-1 Pressure–Temperature Ratings

Joining Material	Working Temp. °F	Working Temp. °C	Maximum Working Gage Pressure, for Standard Water Tube Sizes (1): ⅛ Through 1, psi	⅛ Through 1, kPa	1¼ Through 2, psi	1¼ Through 2, kPa	2½ Through 4, psi	2½ Through 4, kPa	5 Through 8, psi	5 Through 8, kPa	10 Through 12, psi	10 Through 12, kPa
Alloy Sn50 50-50 tin–lead solder (2)(3)	100	38	200	1 375	175	1 205	150	1 030	135	930	100	685
	150	66	150	1 030	125	860	100	685	90	620	70	480
	200	93	100	685	90	620	75	515	70	480	50	340
	250	120	85	585	75	515	50	340	45	310	40	275
Alloy Sb5 95-5 tin–antimony solder (4)	100	38	1,090 (8)	7 540 (8)	850 (9)	5 880 (9)	705 (9)	4 880 (9)	660 (9)	4 555 (9)	500 (8)	3 460 (8)
	150	66	625 (10)	4 315 (10)	485 (10)	3 365 (10)	405 (10)	2 790 (10)	375 (10)	2 605 (10)	285 (11)	1 975 (11)
	200	93	505 (11)	3 500 (11)	395 (10)	2 730 (10)	325 (10)	2 265 (10)	305 (10)	2 115 (10)	230 (11)	1 605 (11)
	250	120	270	1 885	210	1 475	175	1 220	165	1 135	125	865
Alloy E (5)	100	38	710 (10)	4 905 (10)	555 (10)	3 825 (10)	460 (10)	3 175 (10)	430 (10)	2 965 (10)	325 (11)	2 255 (11)
	150	66	475 (11)	3 275 (11)	370 (10)	2 550 (10)	305 (10)	2 115 (10)	285 (11)	1 975 (11)	215 (11)	1 500 (11)
	200	93	375	2 595	290	2 025	240 (11)	1 680 (11)	225 (11)	1 570 (11)	170	1 190
	250	120	320	2 230	250	1 735	205	1 440	195	1 340	145	1 020
Alloy HB (6)	100	38	1,035 (8)	7 135 (8)	805 (9)	5 560 (9)	670 (9)	4 615 (9)	625 (8)	4 305 (8)	475 (8)	3 275 (8)
	150	66	710 (10)	4 905 (10)	555 (10)	3 825 (10)	460 (10)	3 175 (10)	430 (10)	2 965 (10)	325 (10)	2 255 (10)
	200	93	440 (11)	3 045 (11)	345 (11)	2 375 (11)	285 (11)	1 970 (11)	265 (11)	1 840 (11)	200	1 400
	250	120	430 (11)	2 970 (11)	335 (11)	2 315 (11)	275 (11)	1 920 (11)	260 (11)	1 800 (11)	195	1 365
Joining materials melting at or above 1,100°F (593°C) (7)	Pressure–temperature ratings consistent with the materials and procedures employed.											

GENERAL NOTE: For extremely low working temperatures in the 0°F to −200°F (−18°C to −93°C) range, it is recommended that a joint material melting at or above 1,100°F (593°C) be employed [see Note (7)].

NOTES:

(1) Standard water tube sizes per ASTM B88.
(2) ASTM B32 Alloy Grade Sn50.
(3) The Safe Drinking Water Act Amendment of 1986 prohibits the use in potable water systems of any solder having a lead content in excess of 0.2%.
(4) ASTM B32 Alloy Grade Sb5.
(5) ASTM B32 Alloy Grade E.
(6) ASTM B32 Alloy Grade HB.
(7) These joining materials are defined as *brazing alloys* by the American Welding Society.
(8) The solder joint exceeds the strength of Types L and M tube in drawn temper and Type K tube in annealed temper.
(9) The solder joint exceeds the strength of Types K, L, and M tube in drawn and annealed tempers.
(10) The solder joint exceeds the strength of Type M tube in drawn temper and Types K and L tube in annealed temper.
(11) The solder joint exceeds the strength of Type L tube in annealed temper.

NONMANDATORY APPENDIX B
FITTING RATING

The rated internal working pressures of the fitting are shown in Table 1. These values are the same as those calculated for annealed temper ASTM B88 Type L copper water tube. The rated internal working pressures for annealed temper ASTM B88 Type L copper water tube are calculated as follows:

where

$$P = \frac{2St}{D - 0.8t}$$

D = maximum outside diameter, in. from annealed temper ASTM B88 for Type L copper water tube
P = rated working pressure at temperature, psi
S = allowable stress at temperature, psi from ASME B31.1 or ASME B31.9 for annealed temper ASTM B88 Type L copper water tube
t = minimum wall thickness, in. from annealed temper ASTM B88 for Type L copper water tube

(12)

Table II-2 Internal Pressure–Temperature Ratings for Copper Fittings, psi

Standard Water Tube Size [Note (1)]	−20°F to 100°F	150°F	200°F	250°F	300°F	350°F	400°F
1/4	910	770	740	725	710	605	455
3/8	775	660	635	620	610	515	385
1/2	720	610	585	575	565	480	360
5/8	630	535	515	505	490	420	315
3/4	580	490	475	465	455	385	290
1	490	420	400	395	385	325	245
1 1/4	435	370	355	350	340	290	215
1 1/2	405	345	330	325	315	270	200
2	360	305	295	290	280	240	180
2 1/2	335	285	270	265	260	220	165
3	315	265	255	250	245	210	155
3 1/2	300	255	245	240	235	200	150
4	290	245	235	230	225	195	145
5	265	225	215	215	210	175	130
6	250	210	200	200	195	165	125
8	270	225	220	215	210	180	135

GENERAL NOTES:
(a) The fitting pressure–temperature rating applies to the largest opening of the fitting.
(b) The fitting pressure–temperature rating is calculated as shown in Nonmandatory Appendix A, then rounded down to the nearest unit of 5.

NOTE:
(1) For size designation of fittings, see para. 4.1.

Table II-3 Inspection Tolerance

Standard Water Tube and Pipe Thread Sizes	Tolerance, in.
1/8, 1/4, 3/8 [Note (1)]	±0.05
1/2, 5/8, 3/4	±0.06
1, 1 1/4, 1 1/2, 2	±0.08
2 1/2, 3, 3 1/2	±0.11
4 and 5	±0.12
6 and 8	±0.16

NOTE:
(1) 1/8 size is 1/4 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B280.

Table II-4 Pressure–Temperature Ratings (12)

Joining Material	Temperature, °F	Maximum Gage Pressure for Standard Water Tube Sizes, psi [Note (1)] 1/8 Through 1	1 1/4 Through 2	2 1/2 Through 4	5 Through 8
Alloy Sn50	100	200	175	150	135
50–50 tin–lead solder	150	150	125	100	90
[Notes (2), (3)]	200	100	90	75	70
	250	85	75	50	45
Alloy Sb5	100	1,090 [Note (4)]	850 [Note (5)]	705 [Note (5)]	660 [Note (5)]
95–5 tin–antimony solder	150	625 [Note (6)]	485 [Note (6)]	405 [Note (6)]	375 [Note (6)]
[Note (7)]	200	505 [Note (8)]	395 [Note (6)]	325 [Note (6)]	305 [Note (6)]
	250	270	210	175	165
Alloy E	100	710 [Note (6)]	555 [Note (6)]	460 [Note (6)]	430 [Note (6)]
[Note (9)]	150	475 [Note (8)]	370 [Note (6)]	305 [Note (6)]	285 [Note (8)]
	200	375	290	240 [Note (8)]	225 [Note (8)]
	250	320	250	205	195
Alloy HB	100	1,035 [Note (4)]	805 [Note (5)]	670 [Note (5)]	625 [Note (4)]
[Note (10)]	150	710 [Note (6)]	555 [Note (6)]	460 [Note (6)]	430 [Note (6)]
	200	440 [Note (8)]	345 [Note (8)]	285 [Note (8)]	265 [Note (8)]
	250	430 [Note (8)]	335 [Note (8)]	275 [Note (8)]	260 [Note (8)]
Joining materials melting at or above 1,100°F [Note (11)]		Pressure–temperature ratings consistent with the materials and procedures employed			

GENERAL NOTE: For temperatures in the 0°F to −200°F range, it is recommended that a joint material melting at or above 1,100°F be employed [see Note (9)].

NOTES:
(1) Standard water tube sizes per ASTM B88.
(2) ASTM B32 Alloy Grade Sn50.
(3) The Safe Drinking Water Act Amendments of 1986 prohibit the use of any solder having a lead content in excess of 0.2% in potable water systems.
(4) The solder joint exceeds the strength of Types L and M tube in drawn temper and Type K tube in annealed temper.
(5) The solder joint exceeds the strength of Types K, L, and M tube in drawn and annealed tempers.
(6) The solder joint exceeds the strength of Type M tube in drawn temper and Types L and K in annealed temper.
(7) ASTM B32 Alloy Grade Sb5.
(8) The solder joint exceeds the strength of Type L tube in annealed temper.
(9) ASTM B32 Alloy Grade E.
(10) ASTM B32 Alloy Grade HB.
(11) These joining materials are defined as "brazing alloys" by the American Welding Society.

NONMANDATORY APPENDIX A FITTING RATING

(12)

The pressure–temperature ratings of the fittings are shown in Table 2 (Table I-2). These values are the same as those calculated for annealed temper ASTM B88 Type L copper water tube. The rated internal working pressures for annealed temper ASTM B88 Type L copper water tube are calculated as follows:

$$p = \frac{2St}{D - 0.8t}$$

where

D = maximum outside diameter, mm (in.), for annealed temper ASTM B88 Type L water tube

p = rated pressure at temperature, kPa (psi)

S = allowable stress at temperature, kPa (psi), from ASME B31.1 or ASME B31.9, for annealed temper ASTM B88 Type L copper water tube

t = minimum wall thickness, mm (in.), for annealed temper ASTM B88 Type L water tube

5.2 Special alloys or constructions used in component, including tubing with a wall thickness less than indicated in Table 5.1 may be considered acceptable. Among the factors taken into consideration when judging the acceptability are:

a) Resistance to mechanical abuse,

b) Strength against internal pressure,

c) Resistance to corrosion,

d) Protection against refrigerant contamination, and

e) Conformity with requirements of safety codes; such as the Safety Code for Mechanical Refrigeration, ASHRAE 15, as compared to tubing of the minimum wall thickness indicated.

5.3 In judging the protection of tubing, consideration is given to the likelihood of damage occurring during handling, packing and shipment. Shielding to prevent accidental damage from objects such as tools falling on or otherwise striking the tubing shall be provided in the form of baffles, channels, flanges, perforated metal, or similar means.

5.4 Copper or steel capillary tubing which is protected against mechanical damage by the assembly or other means shall have a wall thickness not less than 0.020 inch (0.51 mm).

5.4 revised July 12, 2013

Table 5.1
Wall thickness for copper and steel tubing

Outside Diameter,		Minimum wall thickness, inches[a](mm)					
		Copper				Steel	
Inches	(mm)	Protected		Unprotected[b]			
3/16	(4.76)	0.0245	(0.62)	0.0265	(0.67)	0.025	(0.64)
1/4	(6.35)	0.0245	(0.62)	0.0265	(0.67)	0.025	(0.64)
5/16	(7.94)	0.0245	(0.62)	0.0265	(0.67)	0.025	(0.64)
3/8	(9.53)	0.0245	(0.62)	0.0265	(0.67)	0.025	(0.64)
1/2	(12.70)	0.0245	(0.62)	0.0285	(0.72)	0.025	(0.64)
5/8	(15.88)	0.0315	(0.80)	0.0315	(0.80)	0.032	(0.81)
3/4	(19.05)	0.0315	(0.80)	0.0385	(0.98)	0.032	(0.81)
7/8	(22.23)	0.0410	(1.04)	0.0410	(1.04)	0.046	(1.17)
1	(25.40)	0.0460	(1.17)	0.0460	(1.17)	–	
1-1/8	(28.58)	0.0460	(1.17)	0.0460	(1.17)	0.046	(1.17)
1-1/4	(31.75)	0.0505	(1.28)	0.0505	(1.28)	0.046	(1.17)
1-3/8	(34.93)	0.0505	(1.28)	0.0505	(1.28)	–	
1-1/2	(38.10)	0.0555	(1.41)	0.0555	(1.41)	0.062	(1.58)
1-5/8	(41.28)	0.0555	(1.41)	0.0555	(1.41)	–	
2-1/8	(53.98)	0.0640	(1.63)	0.0640	(1.63)	–	
2-5/8	(66.68)	0.0740	(1.88)	0.0740	(1.88)	–	

[a] Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.
[b] See 3.4.30.

5.5 Tubing shall be constructed of corrosion-resistant material such as copper or shall be plated, dipped, coated, or otherwise treated to resist external corrosion. Aluminum tubing may be used. See 4.7 and 5.2.

46 Refrigerant Tubing and Hoses

46.1 Tubing

46.1.1 The wall thickness of copper or steel tubing used to connect components in the refrigerant systems shall be not less than indicated in Table 46.1.

Exception: Copper or steel capillary tubing that is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 in (0.51 mm).

46.1.2 Tubing shall be constructed of corrosion-resistant material such as copper, or shall be plated, dipped, coated, or equivalently treated to resist external corrosion. Aluminum may be used where the material is not subject to galvanic corrosion.

Table 46.1
Minimum wall thickness for copper, steel and aluminum tubing

Outside diameter,		Copper				Steel		Aluminum	
		Protected[a]		Unprotected		Protected or unprotected			
in	(mm)	in	(mm)	in	(mm)	in	(mm)	in	(mm)
3/16	(4.76)	0.0279	(0.71)	0.0299	(0.76)	0.0279	(0.71)	0.0350	(0.89)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
5/16	(7.9)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
3/8	(9.5)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
1/2	(12.7)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
5/8	(15.9)	0.0315	(0.800)	0.0315	(0.800)	0.032	(0.81)	0.0488	(1.24)
3/4	(19.1)	0.0315	(0.800)	0.0385	(0.978)	0.032	(0.81)	0.0488	(1.24)
7/8	(22.2)	0.0410	(1.041)	0.0410	(1.041)	0.046	(1.17)	0.0650	(1.65)
1	(25.4)	0.0460	(1.168)	0.0460	(1.168)	–	–	0.0720	(1.83)

NOTE – Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.

[a] Within the product.

46.1.3 Tubing forming part of components such as evaporators or condensers, where protection is afforded by inherent construction, shall be judged according to Strength Test – Pressure Containing Components, Section 76.

46.1.4 Special alloys or constructions used in components of the refrigerant system including tubing with a wall thickness less than indicated in 46.1.1 are acceptable, subject to an investigation that considers:

a) Resistance to mechanical abuse,

b) Strength against internal pressure,

c) Resistance to corrosion,

d) Protection against refrigerant contamination, and

ONLINE CERTIFICATIONS DIRECTORY

Search results

You may choose to **Refine Your Search.**

Company Name	Category Name	Link to File
MUELLER STREAMLINE CO	Manual Valves	*MHKZ.MH48476*
MUELLER STREAMLINE CO	Tubing, Refrigerant - Component	*SFCS2.SA32907*
MUELLER STREAMLINE CO	Tubing, Refrigerant Certified for Canada - Component	*SFCS8.SA32907*

Model number information is not published for all product categories. If you require information about a specific model number, please contact Customer Service for further assistance.

ONLINE CERTIFICATIONS DIRECTORY

SFCS2.GuideInfo
Tubing, Refrigerant - Component

View Listings Page Bottom

[Refrigeration Equipment - Component] (Refrigeration Accessories - Component) Tubing, Refrigerant - Component

See General Information for Refrigeration Accessories - Component

The components covered under this category are incomplete in certain constructional features or restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. THE FINAL ACCEPTANCE OF THE COMPONENT IS DEPENDENT UPON ITS INSTALLATION AND USE IN EQUIPMENT SUBMITTED TO UL

USE

This category covers tubing, tubing assemblies, vibration eliminators and refrigerant recovery/recycling hose assemblies intended for use with air conditioning and refrigeration equipment.

CONDITIONS OF ACCEPTABILITY

Consideration is to be given to the Conditions of Acceptability specified in the individual Reports when these components are employed in the end-use equipment.

REQUIREMENTS

The basic standard used to investigate tubing, tubing assemblies and vibration eliminators in this category is ANSI/UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical."

The basic standard used to investigate refrigerant recovery/recycling hose assemblies in this category is ANSI/UL 1963, "Refrigerant Recovery/Recycling Equipment."

* *

UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. UL shall not incur any obligation or liability for any loss, expense or damages, including incidental or consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Guide Information.

Last Updated on 2011-07-06

Questions? Print this page Terms of Use Page Top

SFCS2.SA32907
Tubing, Refrigerant - Component

Page Bottom

Tubing, Refrigerant - Component

See General Information for Tubing, Refrigerant - Component

MUELLER STREAMLINE CO SA32907

SUITE 150
8285 TOURNAMENT DR
MEMPHIS, TN 38125 USA

Model Series 008, 010, 012, 014, 018, 406, 408, 410, 412, 510, 512, 514, 518, 608, 610, 612, 614, 618, 810, 812, 814, 818. May be followed by additional alpha-numeric suffixes.

Model Series DEHYDRATED, ACR, K-WALL. May be followed by additional alph-numeric suffixes.

Marking: Company name and model designation.

Last Updated on 2012-06-25

ONLINE CERTIFICATIONS DIRECTORY

SFCS8.GuideInfo
Tubing, Refrigerant Certified for Canada - Component

View Listings Page Bottom

[Refrigeration Equipment Certified for Canada - Component] (Refrigeration Accessories Certified for Canada - Component) Tubing, Refrigerant Certified for Canada - Component

See General Information for Refrigeration Accessories Certified for Canada - Component

The components covered under this category are incomplete in certain constructional features or restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. THE FINAL ACCEPTANCE OF THE COMPONENT IS DEPENDENT UPON ITS INSTALLATION AND USE IN EQUIPMENT SUBMITTED TO UL

USE

This category covers tubing, tubing assemblies, vibration eliminators and refrigerant recovery/recycling hose assemblies intended for use with air conditioning and refrigeration equipment.

CONDITIONS OF ACCEPTABILITY

Consideration is to be given to the Conditions of Acceptability specified in the individual Reports when these components are employed in the end-use equipment.

REQUIREMENTS

The basic standard used to investigate products in this category is CSA-C22.2 No. 140.3, "Refrigerant-Containing Components for Use in Electrical Equipment."

UL MARKING

Components Recognized under UL's Component Recognition Program are identified by markings consisting of the Recognized company's identification and catalog, model, or other product designation. In addition, components produced under the UL Component Recognition Program will also bear the Recognized Component Mark for Canada.

The Listing or Classification Mark of UL is not authorized for use on, or in connection with, Recognized Components. Only those components that actually bear the "Marking" should be considered as being covered under the Component Recognition Program.

* *

UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. UL shall not incur any obligation or liability for any loss, expense or damages, including incidental or consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Guide Information.

Last Updated on 2011-07-06

Questions? Print this page Terms of Use Page Top

Mueller Streamline Co.
8285 Tournament Drive, Suite 150
Memphis, TN 38125
P 901.753.3200

STANDARD COPPER TUBE

Mueller Copper Tube products are manufactured in the USA. All tubing produced in Fulton, MS, and Wynne, AR, is seamless and of UNS C12200 grade of copper and is manufactured to meet the chemical, mechanical, cleanness, and eddy current testing requirements of the applicable ASTM specifications set forth below.

Although Mueller Copper Tube strives to meet all requirements specified in ASTM, Standard Tube may not fully meet ASTM dimensional requirements. Standard Tube will be provided unless Certified Tube is clearly defined on the Purchase Order. When specified at order placement, Mueller Copper Tube can supply Certified Tube to meet all requirements of the current applicable ASTM specification, at an additional cost.

- Streamline Copper Water Tube (Types K,L,M) is produced in accordance with, ASTM B88 and ANSI/NSF 61**
- Streamline Copper Refrigeration Service Coils are produced in accordance with ASTM B280
- Streamline Nitrogenized ACR Hard Drawn Copper Tube is produced in accordance with ASTM B280
- Streamline Copper Drainage Tube (DWV) is produced in accordance with ASTM B306
- Oxygen & Medical Service Tube - To ASTM B819 (Types K & L) Hard Drawn Straight Lengths Only in accordance to CGA Cleanness Specification; CGA G4.1 (Compressed Gas Association); & NFPA 99 (Health Care Facilities).

** NSF 61 Restriction Statement Copper Tube (Alloy C12200) is certified by NSF to ANSI/NSF Standard 61 for public water supplies meeting or in the process of meeting the U.S. EPA Lead and Copper Rule (56FR 26460, June 7, 1991). Water supplies with pH less than 6.5 may require corrosion control to limit copper solubility in drinking water."

Last revision: March 11, 2011

Mueller Streamline Co.
8285 Tournament Drive, Suite 150
Memphis, TN 38125
P 901.753.3200

C UL US
700 PSI R410A

April 17, 2012

SUBJECT: **Streamline Copper Tube & Fittings UL Recognized to 700 PSI Operating Pressures to Support R410A and Sub Critical CO_2 Applications**

To Our Valued Customers:

Mueller Streamline Co. has long been a leader in providing copper tube and fittings for refrigerant-bearing applications in HVAC and refrigeration systems. The refrigerants used in these systems have evolved significantly since we developed and patented the braze/solder-type copper fitting back in 1930. While Streamline copper tube and fittings are proudly made in accordance with the applicable ASTM/ASME specifications, the evolution toward higher pressure refrigerants encouraged us to attain bolder thresholds.

To provide customers the highest level of assurance that our products will continue to meet the higher pressure demands of modern refrigerants like R410A and sub-critical CO_2, we have taken the additional step of expanding our already extensive testing procedures and implementing third-party verification through Underwriters Laboratories (UL).

Mueller Streamline Co. is now able to offer the only copper tube and fittings UL Recognized to 700PSI (see table below). This recognition follows years of testing that includes hoop strain, cyclic fatigue, hydrostatic burst, thermal cycling, and more. The testing and third-party certification validates performance of these products to operating pressures of 700psi at 250°F.

Product Line	*Product Type*	*Diameter*
Copper Tube	• Streamline Refrigeration Service Coils • Streamline Line Sets & Mini-Splits • Streamline ACR - Type L (Hard Lengths) • Streamline ACR - Type K (Hard Lengths)	1/8" – 1-1/8" 1/8" – 1-1/8" 1/8" – 1-3/8" 1/8" – 2-5/8"
Copper Fittings	• Streamline Wrot Solder-Joint Pressure	1/8" – 2-5/8"

As new technologies and refrigerants emerge, Mueller Streamline Co. is committed to being a resource to our customers and ensuring that our products are safe and reliable. If you have any product questions please contact your local sales representative.

for use at pressure–temperature ratings in accordance with para. 302.2.1 or para. 302.2.2, as applicable. The rules in para. 304 are intended for pressure design of components not covered in Table 326.1, but may be used for a special or more-rigorous design of such components, or to satisfy requirements of para. 302.2.2. Designs shall be checked for adequacy of mechanical strength as described in para. 302.5.

304 PRESSURE DESIGN OF COMPONENTS

304.1 Straight Pipe

304.1.1 General

(a) The required thickness of straight sections of pipe shall be determined in accordance with eq. (2):

$$t_m = t + c \tag{2}$$

The minimum thickness, T, for the pipe selected, considering manufacturer's minus tolerance, shall be not less than t_m.

(b) The following nomenclature is used in the equations for pressure design of straight pipe:

c = sum of the mechanical allowances (thread or groove depth) plus corrosion and erosion allowances. For threaded components, the nominal thread depth (dimension h of ASME B1.20.1, or equivalent) shall apply. For machined surfaces or grooves where the tolerance is not specified, the tolerance shall be assumed to be 0.5 mm (0.02 in.) in addition to the specified depth of the cut.

D = outside diameter of pipe as listed in tables of standards or specifications or as measured

d = inside diameter of pipe. For pressure design calculation, the inside diameter of the pipe is the maximum value allowable under the purchase specification.

E = quality factor from Table A-1A or A-1B

P = internal design gage pressure

S = stress value for material from Table A-1

T = pipe wall thickness (measured or minimum in accordance with the purchase specification)

t = pressure design thickness, as calculated in accordance with para. 304.1.2 for internal pressure or as determined in accordance with para. 304.1.3 for external pressure

t_m = minimum required thickness, including mechanical, corrosion, and erosion allowances

W = weld joint strength reduction factor in accordance with para. 302.3.5(e)

Y = coefficient from Table 304.1.1, valid for $t < D/6$ and for materials shown. The value of Y may be interpolated for intermediate temperatures. For $t \geq D/6$,

Table 304.1.1 Values of Coefficient *Y* for $t < D/6$

	Temperature, °C (°F)					
Materials	≤ 482 (900 & Lower)	510 (950)	538 (1,000)	566 (1,050)	593 (1,100)	≥ 621 (1,150 & Up)
Ferritic steels	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic steels	0.4	0.4	0.4	0.4	0.5	0.7
Other ductile metals	0.4	0.4	0.4	0.4	0.4	0.4
Cast iron	0.0	...	...	...	...	...

$$Y = \frac{d + 2c}{D + d + 2c}$$

304.1.2 Straight Pipe Under Internal Pressure

(a) For $t < D/6$, the internal pressure design thickness for straight pipe shall be not less than that calculated in accordance with either eq. (3a) or eq. (3b):

$$t = \frac{PD}{2(SEW + PY)} \tag{3a}$$

$$t = \frac{P(d + 2c)}{2[SEW - P(1 - Y)]} \tag{3b}$$

(b) For $t \geq D/6$ or for $P/SE > 0.385$, calculation of pressure design thickness for straight pipe requires special consideration of factors such as theory of failure, effects of fatigue, and thermal stress.

304.1.3 Straight Pipe Under External Pressure. To determine wall thickness and stiffening requirements for straight pipe under external pressure, the procedure outlined in the BPV Code, Section VIII, Division 1, UG-28 through UG-30 shall be followed, using as the design length, L, the running centerline length between any two sections stiffened in accordance with UG-29. As an exception, for pipe with $D_o/t < 10$, the value of S to be used in determining P_{a2} shall be the lesser of the following values for pipe material at design temperature:

(a) 1.5 times the stress value from Table A-1 of this Code, or

(b) 0.9 times the yield strength tabulated in Section II, Part D, Table Y-1 for materials listed therein

(The symbol D_o in Section VIII is equivalent to D in this Code.)

304.2 Curved and Mitered Segments of Pipe

304.2.1 Pipe Bends. The minimum required thickness, t_m, of a bend, after bending, in its finished form, shall be determined in accordance with eqs. (2) and (3c)

$$t = \frac{PD}{2[(SEW/I) + PY]} \tag{3c}$$

11/12/14 Swartz

B31.3-2012 Eq 3a rearranged for P

$$t = \frac{PD}{2(SEW + PY)}$$

$$2t(SEW + PY) = PD$$

$$2tSEW + 2tPY = PD$$

$$PD = 2tSEW + 2tPY$$

$$PD - 2tPY = 2tSEW$$

$$P(D - 2tY) = 2tSEW$$

$$P = \frac{2tSEW}{D - 2Yt}$$

$Y = .4$

$W = 1$

$E = 1$

$$P = \frac{2tS}{D - .8t}$$

Table A-1 Basic Allowable Stresses in Tension for Metals[1] (Cont'd)

Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Nominal Composition	Product Form	Spec. No.	UNS No.	Class/ Condition/ Temper	Size Range, in.	P-No. (5)(46)	Notes	Min. Temp., °F (6)	Specified Min. Strength, ksi Tensile	Specified Min. Strength, ksi Yield
Copper and Copper Alloy Pipes and Tubes (2)										
...	Pipe	B42	C10200	061	...	31	...	−452	30	9
...	Pipe	B42	C12000	061	...	31	...	−452	30	9
...	Pipe	B42	C12200	061	...	31	...	−452	30	9
...	Tube	B75	C10200	050	...	31	...	−452	30	9
...	Tube	B75	C10200	060	...	31	...	−452	30	9
...	Tube	B75	C12000	050	...	31	...	−452	30	9
...	Tube	B75	C12000	060	...	31	...	−452	30	9
...	Tube	B75	C12200	050	...	31	...	−452	30	9
...	Tube	B75	C12200	060	...	31	...	−452	30	9
...	Tube	B68	C12200	050	...	31	(24)	−452	30	9
...	Tube	B68	C12200	060	...	31	(24)	−452	30	9
...	Tube	B88	C12200	050	...	31	(24)	−452	30	9
...	Tube	B88	C12200	060	...	31	(24)	−452	30	9
...	Tube	B280	C12200	060	...	31	(24)	−452	30	9
Red brass	Pipe	B43	C23000	061	...	32	...	−452	40	12
90Cu–10Ni	...	B467	C70600	WO50	> 4.5 O.D.	34	(14)	−452	38	13
90Cu–10Ni	...	B467	C70600	WO61	> 4.5 O.D.	34	(14)	−452	38	13
90Cu–10Ni	...	B466	C70600	Annealed	...	34	(14)	−452	38	13
90Cu–10Ni	...	B467	C70600	WO50	≤ 4.5 O.D.	34	(14)	−452	40	15
90Cu–10Ni	...	B467	C70600	WO61	≤ 4.5 O.D.	34	(14)	−452	40	15
70Cu–30Ni	...	B467	C71500	WO50	> 4.5 O.D.	34	(14)	−452	45	15
70Cu–30Ni	...	B467	C71500	WO61	> 4.5 O.D.	34	(14)	−452	45	15
80Cu–20Ni	...	B466	C71000	Annealed	≤ 4.5 O.D.	34	(14)	−452	45	16
...	Pipe	B42	C10200	H55	NPS $2\frac{1}{2}$ thru 12	31	(14)(34)	−452	36	30
...	Pipe	B42	C12000	H55	NPS $2\frac{1}{2}$ thru 12	31	(14)(34)	−452	36	30
...	Pipe	B42	C12200	H55	NPS $2\frac{1}{2}$ thru 12	31	(14)(34)	−452	36	30
...	Tube	B75	C10200	H58	...	31	(14)(34)	−452	36	30
...	Tube	B75	C12000	H58	...	31	(14)(34)	−452	36	30
...	Tube	B75	C12200	H58	...	31	(14)(34)	−452	36	30
...	Tube	B88	C12200	H58	...	31	(14)(24)(34)	−452	36	30
70Cu–30Ni	...	B466	C71500	060	...	34	(14)	−452	52	18
70Cu–30Ni	...	B467	C71500	WO50	≤ 4.5 O.D.	34	(14)	−452	50	20
70Cu–30Ni	...	B467	C71500	WO61	≤ 4.5 O.D.	34	(14)	−452	50	20
...	Pipe	B42	C10200	H80	NPS $\frac{1}{8}$ thru 2	31	(14)(34)	−452	45	40
...	Pipe	B42	C12000	H80	NPS $\frac{1}{8}$ thru 2	31	(14)(34)	−452	45	40
...	Pipe	B42	C12200	H80	NPS $\frac{1}{8}$ thru 2	31	(14)(34)	−452	45	40
...	Tube	B75	C10200	H80	...	31	(14)(34)	−452	45	40
...	Tube	B75	C12000	H80	...	31	(14)(34)	−452	45	40
...	Tube	B75	C12200	H80	...	31	(14)(34)	−452	45	40
Plates and Sheets										
...	...	B152	C10200	025	...	31	(14)(24)	−452	30	10
...	...	B152	C10400	025	...	31	(14)(24)	−452	30	10
...	...	B152	C10500	025	...	31	(14)(24)	−452	30	10
...	...	B152	C10700	025	...	31	(14)(24)	−452	30	10
...	...	B152	C12200	025	...	31	(14)(24)	−452	30	10
...	...	B152	C12300	025	...	31	(14)(24)	−452	30	10

Table A-1 Basic Allowable Stresses in Tension for Metals[1] (Cont'd)

Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Basic Allowable Stress, *S*, ksi (1), at Metal Temperature, °F														
Min. Temp. to 100	150	200	250	300	350	400	450	500	550	600	650	700	UNS No.	Spec. No.
													Copper and Copper Alloy Pipes and Tubes (2)	
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C10200	B42
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12000	B42
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B42
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C10200	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C10200	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12000	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12000	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B75
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B68
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B68
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B88
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B88
6.0	5.1	4.9	4.8	4.7	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B280
8.0	7.9	7.9	7.9	7.9	7.0	5.0	2.0	...	...	...	...	...	C23000	B43
8.7	8.4	8.2	8.0	7.8	7.7	7.5	7.4	7.3	7.0	6.0	...	...	C70600	B467
8.7	8.4	8.2	8.0	7.8	7.7	7.5	7.4	7.3	7.0	6.0	...	...	C70600	B467
8.7	8.4	8.2	8.0	7.8	7.7	7.5	7.4	7.3	7.0	6.0	...	...	C70600	B466
10.0	9.7	9.5	9.3	9.1	8.9	8.7	8.5	8.0	7.0	6.0	...	...	C70600	B467
10.0	9.7	9.5	9.3	9.1	8.9	8.7	8.5	8.0	7.0	6.0	...	...	C70600	B467
10.0	9.6	9.4	9.2	9.0	8.8	8.6	8.4	8.2	8.1	8.0	7.9	7.8	C71500	B467
10.0	9.6	9.4	9.2	9.0	8.8	8.6	8.4	8.2	8.1	8.0	7.9	7.8	C71500	B467
10.7	10.6	10.5	10.4	10.2	10.1	9.9	9.6	9.3	8.9	8.4	7.7	7.0	C71000	B466
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C10200	B42
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C12000	B42
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C12200	B42
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C10200	B75
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C12000	B75
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C12200	B75
12.0	11.6	10.9	10.4	10.0	9.8	9.5	...	...	...	...	...	...	C12200	B88
12.0	11.6	11.3	11.0	10.8	10.6	10.3	10.1	9.9	9.8	9.6	9.5	9.4	C71500	B466
13.3	12.9	12.6	12.3	12.0	11.7	11.5	11.2	11.0	10.8	10.7	10.5	10.4	C71500	B467
13.3	12.9	12.6	12.3	12.0	11.7	11.5	11.2	11.0	10.8	10.7	10.5	10.4	C71500	B467
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C10200	B42
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C12000	B42
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C12200	B42
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C10200	B75
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C12000	B75
15.0	14.5	13.6	13.0	12.6	12.2	4.3	...	...	...	...	...	...	C12200	B75
													Plates and Sheets	
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C10200	B152
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C10400	B152
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C10500	B152
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C10700	B152
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C12200	B152
6.7	5.7	5.4	5.3	5.0	4.0	3.0	2.3	1.7	...	...	...	...	C12300	B152

502.4.4 Mechanical Strength. When necessary to prevent damage, collapse, or buckling due to superimposed loads from supports, backfill, or other causes, the pipe wall thickness shall be increased, or, if this is impractical or would cause excessive local stresses, the factors that would contribute to damage of the piping shall be compensated for by other design methods.

Section 502 pertains to ratings, stress values, stress criteria, design allowances, and minimum design values, and formulates the permissible variations to these factors used in the design of piping.

PART 2
DESIGN OF PIPING COMPONENTS

503 CRITERIA FOR DESIGN OF PIPING COMPONENTS

The design of piping components, considering the effects of pressure, and providing for mechanical, corrosion, and erosion allowances, shall be in accordance with section 504. In addition, the designs must be checked for adequacy of mechanical strength under other applicable loadings as given in section 501.

504 PRESSURE DESIGN OF PIPING COMPONENTS

504.1 Straight Pipe

504.1.1 General

(a) The required wall thickness of straight sections of pipe shall be determined in accordance with eq. (2). (Also, see section 503.)

$$t_m = t + c \tag{2}$$

(b) The notations described below are used in the equations for the pressure design of straight pipe.

c = for internal pressure, the sum, in. (mm), of the mechanical allowances (thread depth, groove depth, and manufacturer's minus tolerance) plus corrosion and erosion allowances. (See para. 502.4.1.) For threaded components, the nominal thread depth (dimension h of ASME B1.20.1, or equivalent) shall apply. For machined surfaces or grooves, where the tolerance is not specified, the tolerance shall be assumed to be $\frac{1}{64}$ in. (0.5 mm) in addition to the specified depth of the cut.
= for external pressure, the sum, in. (mm), of corrosion and erosion allowances plus manufacturer's minus tolerance (see para. 502.4.1)

D_o = outside diameter of pipe, in. (mm)

d = inside diameter of pipe, in. (mm), excluding metal required for corrosion or erosion allowance, manufacturer's minus tolerance, and any allowance required for the depth of internal threads or grooves

P = internal design pressure (see para. 501.2.2), psi (kPa), or external design pressure (see para. 501.2.3), psi (kPa)

S = applicable allowable hoop stress in accordance with para. 502.3.1 and Table 502.3.1, psi (kPa)

t = pressure design wall thickness, in. (mm), as calculated from eqs. (3a) and (3b) for internal pressure, or in accordance with the procedures given in para. 504.1.3 for external pressure

t_m = minimum required wall thickness, in. (mm), satisfying requirements for design pressure and mechanical, corrosion, and erosion allowances

y = coefficient for materials indicated: for ductile nonferrous materials, use $y = 0.4$ (see Note); for ferritic steels, use $y = 0.4$ (see Note); for austenitic steels, use $y = 0.4$ (see Note). For cast iron, use $y = 0.0$.

NOTE: If D_o/t is in the range of 4–6, use $y = d/(d + D_o)$ for ductile materials.

504.1.2 Straight Pipe Under Internal Pressure. For metallic pipe with diameter–thickness ratios $D_o/t > 4$, the internal pressure design wall thickness, t, shall be calculated using eq. (3a) or (3b).

$$t = \frac{PD_o}{2(S + Py)} \tag{3a}$$

or

$$t = \frac{Pd}{2(S + Py - P)} \tag{3b}$$

where

$$P = \frac{2St}{D_o - 2yt}$$

NOTE: The following simpler alternative equations, which give somewhat greater wall thickness, may be employed:

$$t = \frac{PD_o}{2S}$$

or

$$t = \frac{Pd}{2(S - P)}$$

where

$$P = \frac{2St}{D_o}$$

504.1.3 Straight Pipe Under External Pressure. To determine wall thickness and stiffening requirements for straight pipe under external pressure, the procedure outlined in the BPV Code, Section VIII, Division 1, UG-28 through UG-30 shall be followed, using as the design length, L, the running centerline length between any two sections stiffened in accordance with UG-29. As an exception, for pipe with $D_o/t < 10$, the value of S to be

Table 502.3.1 Maximum Allowable Stress Values, ksi (Cont'd)
(Multiply by 1,000 to Obtain psi)

Material	Spec. No.	Size or Wall, in.	Copper or Copper Alloy No.	Temper	Min. Tensile Strength, ksi [Note (3)]	Min. Yield Strength, ksi [Note (3)]
Seamless Copper and Copper Alloy Pipe and Tube						
Copper pipe	ASTM B42	All	C10200 C12200	Annealed (O61)	30.0	9.0
Copper pipe [Note (4)]	ASTM B42	$\frac{1}{8}$–2, incl.	C10200 C12200	Hard drawn (H80)	45.0	40.0
Copper pipe [Note (4)]	ASTM B42	2–12, incl.	C10200 C12200	Light drawn (H55)	36.0	30.0
Red brass pipe	ASTM B43	All	C23000	Annealed (O61)	40.0	12.0
Copper tube	ASTM B68	All	C10200 C12200	Light anneal, soft anneal (O50, O60)	30.0	9.0
Copper tube	ASTM B75	All	C10200 C12200	Light anneal, soft anneal (O50, O60)	30.0	9.0
Copper tube [Note (4)]	ASTM B75	All	C10200 C12200 C14200	Light drawn (H55)	36.0	30.0
Copper tube [Note (4)]	ASTM B75	Up to 4	C10200 C12200	Hard drawn (H80)	45.0	40.0
Copper tube [Note (4)]	ASTM B88	All	C10200 C12200	Drawn general purpose (H58)	36.0	30.0
Copper tube	ASTM B88	All	C10200 C12200	Light anneal (O50)	30.0	9.0
Copper tube [Note (4)]	ASTM B111	Up to $3\frac{1}{8}$, incl.	C10200 C12200 C14200	Light drawn (H55)	36.0	30.0
Copper tube [Note (4)]	ASTM B111	Up to $3\frac{1}{8}$, incl.	C10200 C12200 C14200	Hard drawn (H80)	45.0	40.0
Copper alloy	ASTM B111	Up to $3\frac{1}{8}$, incl.	C19200	Annealed (O61)	38.0	12.0
Red brass condenser tube	ASTM B111	Up to $3\frac{1}{8}$, incl.	C23000	Annealed (O61)	40.0	12.0

Table 502.3.1 Maximum Allowable Stress Values, ksi (Cont'd)
(Multiply by 1,000 to Obtain psi)

For Metal Temperatures, °F							
100	150	200	250	300	350	400	Spec. No.
							Seamless Copper and Copper Alloy Pipe and Tube
6.0	5.1	4.9	4.8	4.7	4.0	3.0	ASTM B42
12.9	12.9	12.9	12.9	12.5	11.8	4.3	ASTM B42
10.3	10.3	10.3	10.3	10.0	9.7	9.4	ASTM B42
8.0	8.0	8.0	8.0	8.0	7.0	5.0	ASTM B43
6.0	5.1	4.9	4.8	4.7	4.0	3.0	ASTM B68
6.0	5.1	4.9	4.8	4.7	4.0	3.0	ASTM B75
10.3	10.3	10.3	10.3	10.0	9.7	9.4	ASTM B75
12.9	12.9	12.9	12.9	12.5	11.8	4.3	ASTM B75
10.3	10.3	10.3	10.3	10.0	9.7	9.4	ASTM B88
6.0	5.1	4.9	4.8	4.7	4.0	3.0	ASTM B88
10.3	10.3	10.3	10.3	10.0	9.7	9.4	ASTM B111
12.9	12.9	12.9	12.9	12.5	11.8	4.3	ASTM B111
8.0	7.1	6.7	6.4	6.2	...	...	ASTM B111
8.0	8.0	8.0	8.0	8.0	7.0	5.0	ASTM B111

Design pressure shall not exceed that determined by eq. (2).

$$P = \frac{2SE\,(t_m - A)}{D} \tag{2}$$

The engineer may, at his option, use the values of t_m and P determined by the applicable equations in ASME B31.1.

(1) If pipe is ordered by its nominal wall thickness, the manufacturing tolerances on wall thickness must be taken into account. After the minimum wall thickness t_m is determined, this minimum thickness shall be increased to provide the manufacturing tolerance allowed in the applicable pipe specification. The next heavier commercial wall thickness shall then be selected.

(2) When computing the design pressure for a pipe of a definite minimum wall thickness t_m, the value of pressure obtained by eq. (2) may be rounded to the next higher increment of 10 psi (69 kPa).

(b) Ductile Iron Pipe. The thickness of ductile iron pipe shall be determined from one of the following:

(1) ANSI/AWWA C150/A21.50 or C151/A21.51

(2) ANSI A21.14 or A21.52

(3) Federal Specification WW-P-421

The tabulated thicknesses in these standards include allowances for foundry tolerances and water hammer.

(c) Straight Nonmetallic Pipe. The maximum pressure ratings for plastic and other nonmetallic pipe shall be as given in the applicable standards listed in Table 926.1.

904.1.2 Straight Metallic Pipe Under External Pressure. In determining wall thickness and stiffening requirements for straight pipe under external pressure, the procedures outlined in UG-28 of Section VIII, Division 1 of the ASME BPV Code shall be followed.

904.2 Curved and Mitered Segments of Pipe

904.2.1 Pipe Bends

(a) Thickness of Bends. The minimum wall thickness t_m at any point in a completed pipe bend shall not be less than that required by para. 904.1.1. Table 904.2.1 may be used as a guide in specifying wall thickness for ordering pipe to be bent.

(b) Flattening of Bends. Flattening of a bend, as measured by the difference of maximum and minimum diameters, shall not exceed 8% of the average measured outside diameter of the pipe before bending.

Greater flattening may be permitted or less flattening may be required if specified by the engineering design.

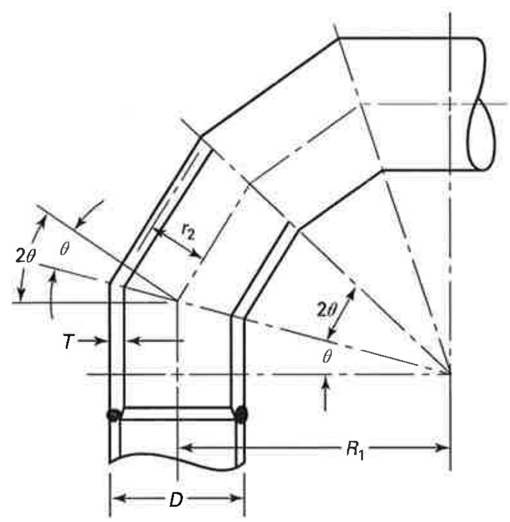
904.2.2 Miter Joints. Thickness determined in accordance with para. 904.1.1 does not allow for discontinuity stresses at the joint between mitered segments of pipe. These discontinuity stresses are negligible for miter angles of 3 deg or less in any service, and may be neglected for miters in nonflammable, nontoxic liquid service at pressures of 50 psig (345 kPa) or less, and for unvalved vents to atmosphere. See Fig. 904.2.2 for nomenclature.

Table 904.2.1 Pipe Thickness for Bends

Radius of Bends, Pipe Diameters, D_n [Note (1)]	Minimum Thickness Recommended Prior to Bending, t_m
6 or greater	1.06
5	1.08
4	1.14
3	1.24

NOTE:
(1) Interpolation is permissible for a radius other than those listed.

Fig. 904.2.2 Nomenclature for Miter Joints



(a) Allowable Pressure. For other services and for pressures in excess of 50 psig (345 kPa), the maximum allowable pressure for miter joints where θ does not exceed $22\frac{1}{2}$ deg shall be the lower positive value calculated by eqs. (3A) and (3B).

$$P = \frac{SET}{r_2}\left(\frac{T}{T + 0.64\tan\theta\sqrt{r_2 T}}\right) \tag{3A}$$

$$P = \frac{SET}{r_2}\left(\frac{R_1 - r_2}{R_1 - 0.5r_2}\right) \tag{3B}$$

Equations (3A) and (3B) apply only when R_1 is at least as great as the value calculated by eq. (4).

Table I-1 Allowable Stresses (Cont'd)

Material	Spec. No.	Alloy No.	Condition	P-No.	Notes	Strengths: Min. Tensile, ksi	Strengths: Min. Yield, ksi	Max. Allowable Stress Value in Tension *SE*, ksi, for Metal Temperature, °F, Not Exceeding: 0 to 100	150	200	250	300	350	400
Copper and Copper Alloys														
Seamless Pipe and Tube														
Copper Pipe, Size range NPS $\frac{1}{8}$–2 incl.	ASTM B 42	102, 122	Annealed	31	. . .	30.0	9.0	6.0	5.1	4.9	4.8	4.7	4.0	3.0
Copper Pipe, Size range NPS $\frac{1}{8}$–2 incl.	ASTM B 42	102, 122	Hard drawn	31	(12)	45.0	40.0	12.9	12.9	12.9	12.9	12.5	11.8	4.3
Copper Pipe, Size range NPS $2\frac{1}{2}$–12 incl.	ASTM B 42	102, 122	Light drawn	31	(12)	36.0	30.0	10.3	10.3	10.3	13.3	10.0	9.7	9.4
Red Brass Pipe	ASTM B 43	230	Annealed	32	. . .	40.0	12.0	8.0	8.0	8.0	8.0	8.0	7.0	5.0
Copper Tube	ASTM B 68	102, 122	Annealed	31	(1)	30.0	9.0	6.0	5.1	4.9	4.8	4.7	4.0	3.0
Copper Tube	ASTM B 75	102, 122	Annealed	31	. . .	30.0	9.0	6.0	5.1	4.9	4.8	4.7	4.0	3.0
Copper Tube	ASTM B 75	102, 122	Light drawn	31	(12)	36.0	30.0	10.3	10.3	10.3	10.3	10.0	9.7	9.4
Copper Tube	ASTM B 75	102, 122	Hard drawn	31	(12)	45.0	40.0	11.3	11.3	11.3	11.3	11.0	10.3	4.3
Copper Tube	ASTM B 88	102, 122	Annealed	31	(1)	30.0	9.0	6.0	5.1	4.9	4.8	4.7	4.0	3.0
Copper Tube	ASTM B 88	102, 122	Drawn	31	(1)(12)	36.0	30.0	10.3	10.3	10.3	10.3	10.0	9.7	9.4
Brass Tube	ASTM B 135	230	Annealed	32	. . .	40.0	12.0	8.0	8.0	8.0	8.0	8.0	7.0	5.0
Copper Tube	ASTM B 280	102, 122	Annealed	31	(1)	30.0	9.0	6.0	5.1	4.8	4.8	4.7	4.0	3.0
Copper Pipe, Threadless	ASTM B 302	102, 122	Drawn	32	(1)	36.0	30.0	10.3	10.3	10.3	10.3	10.0	9.7	9.4

GENERAL NOTES:

(a) See para. 902.3 for discussion of allowable stress values.

(b) The tabulated specifications are ASTM, except as noted. For boiler external piping, the corresponding ASME specifications shall be used. See Section II of the ASME BPV Code.

(c) The stress values may be interpolated to determine allowable stresses for intermediate temperatures.

(d) The P-Numbers indicated in this Appendix are identical to those adopted in Section IX of the ASME BPV Code.

(e) All stress values are shown in units of thousands of pounds-force per square in. (ksi). Multiply by 1000 to obtain values in psi.

(f) Materials listed in Table 926.1 for which allowable stress values are not tabulated in Appendix I may be used at allowable stresses found in ASME B31.1 or in Section I or Section VIII, Division 1 of the ASME BPV Code. However, the temperature limits in this Code shall apply.

metal has been magnetic particle or dye penetrant inspected to ensure complete removal of discontinuities. [Refer to para. 127.4.11(A).]

(B.2.4) All weld repairs of depth exceeding 1 in. (25 mm) or 20% of the section thickness, whichever is the lesser, shall be inspected by radiography in accordance with (B.2.2) above and by magnetic particle or dye penetrant inspection of the finished weld surface. All weld repairs of depth less than 20% of the section thickness, or 1 in. (25 mm), whichever is the lesser, and all weld repairs of section that cannot be effectively radiographed shall be examined by magnetic particle or dye penetrant inspection of the first layer, of each $\frac{1}{4}$ in. (6 mm) thickness of deposited weld metal, and of the finished weld surface. Magnetic particle or dye penetrant testing of the finished weld surface shall be done after postweld heat treatment.

(C) For cast iron and nonferrous materials, no increase of the casting quality factor is allowed except when special methods of examination, prescribed by the material specification, are followed. If such increase is specifically permitted by the material specification, a factor not exceeding 1.0 may be applied.

102.4.7 Weld Strength Reduction Factors. At elevated temperatures, seam welds on longitudinal-welded or spiral-welded pipe can have lower creep strength than the base material. This reduction is a factor in determining the minimum wall thickness for longitudinal-welded or spiral-welded pipe (i.e., not seamless), whether fabricated in accordance with a material specification or fabricated in accordance with the rules of this Code. The weld strength reduction factor, *W*, is given in Table 102.4.7. The designer is responsible to assess application of weld strength reduction factor requirements for welds other than longitudinal and spiral, as applicable (e.g., circumferential welds).

PART 2
PRESSURE DESIGN OF PIPING COMPONENTS

103 CRITERIA FOR PRESSURE DESIGN OF PIPING COMPONENTS

The design of piping components shall consider the effects of pressure and temperature, in accordance with paras. 104.1 through 104.7, including the consideration of allowances permitted by paras. 102.2.4 and 102.4. In addition, the mechanical strength of the piping system shall be determined adequate in accordance with para. 104.8 under other applicable loadings, including but not limited to those loadings defined in para. 101.

104 PRESSURE DESIGN OF COMPONENTS

104.1 Straight Pipe

104.1.1 Straight Pipe Under Internal Pressure. Straight pipe under internal pressure shall have a minimum wall thickness calculated per para. 104.1.2 if the pipe is of seamless construction or is designed for sustained operation below the creep range. Straight pipe under internal pressure shall have a minimum wall thickness calculated per para. 104.1.4 if the pipe is of longitudinal-welded or spiral-welded construction designed for sustained operation within the creep range. (See para. 123.4 for definition of the creep range.)

104.1.2 Straight Pipe Under Internal Pressure — Seamless, Longitudinal Welded, or Spiral Welded and Operating Below the Creep Range

(A) Minimum Wall Thickness. The minimum thickness of pipe wall required for design pressures and for temperatures not exceeding those for the various materials listed in the Allowable Stress Tables, including allowances for mechanical strength, shall not be less than that determined by eq. (7) or (8), as follows:

$$t_m = \frac{PD_o}{2(SE + Py)} + A \qquad (7)^3$$

$$t_m = \frac{Pd + 2SEA + 2yPA}{2(SE + Py - P)} \qquad (8)^3$$

Design pressure shall not exceed

$$P = \frac{2SE(t_m - A)}{D_o - 2y(t_m - A)} \qquad (9)^3$$

$$P = \frac{2SE(t_m - A)}{d - 2y(t_m - A) + 2t_m} \qquad (10)^3$$

where the nomenclature used above is:

(A.1) t_m = minimum required wall thickness, in. (mm)

(A.1.1) If pipe is ordered by its nominal wall thickness, the manufacturing tolerance on wall thickness must be taken into account. After the minimum pipe wall thickness t_m is determined by eq. (7) or (8), this minimum thickness shall be increased by an amount sufficient to provide the manufacturing tolerance allowed in the applicable pipe specification or required by the process. The next heavier commercial wall thickness shall then be selected from thickness schedules such as contained in ASME B36.10M or from manufacturers' schedules for other than standard thickness.

(A.1.2) To compensate for thinning in bends, refer to para. 102.4.5.

(A.1.3) For cast piping components, refer to para. 102.4.6.

[3] *SF* shall be used in place of *SE* where casting quality factors are intended. See definition of *SE*. Units of *P* and *SE* must be identical. Mandatory Appendix A values must be converted to kPa when the design pressure is in kPa.

Table 102.4.7 Weld Strength Reduction Factors to Be Applied When Calculating the Minimum Wall Thickness or Allowable Design Pressure of Components Fabricated With a Longitudinal Seam Fusion Weld

	Weld Strength Reduction Factor for Temperature, °F (°C) [Notes (1)–(6)]										
Steel Group	700 (371)	750 (399)	800 (427)	850 (454)	900 (482)	950 (510)	1,000 (538)	1,050 (566)	1,100 (593)	1,150 (621)	1,200 (649)
Carbon (Norm.) [Notes (7), (8)]	1.00	0.95	0.91	NP	NP	NP	NP	NP	NP	NP	NP
Carbon (Sub Crit) [Notes (8), (9)]	1.00	0.95	0.91	NP	NP	NP	NP	NP	NP	NP	NP
CrMo [Notes (8), (10), (11)]	...	...	1.00	0.95	0.91	0.86	0.82	0.77	0.73	0.68	0.64
CSEF (N+T) [Notes (8), (12), (13)]	...	...	...	...	...	1.00	0.95	0.91	0.86	0.82	0.77
CSEF (Sub Crit) [Notes (8), (9)]	...	...	...	...	1.00	0.73	0.68	0.64	0.59	0.55	0.50
Austenitic stainless (incl. 800H & 800HT) [Notes (14), (15)]	...	...	...	...	...	1.00	0.95	0.91	0.86	0.82	0.77
Autogenously welded austenitic stainless [Note (16)]	...	...	...	...	...	1.00	1.00	1.00	1.00	1.00	1.00

NOTES:

(1) NP = not permitted.

(2) Longitudinal welds in pipe for materials not covered in this Table operating in the creep regime are not permitted. For the purposes of this Table, the start of the creep range is the highest temperature where the nonitalicized stress values end in Mandatory Appendix A for the base material involved.

(3) All weld filler metal shall be a minimum of 0.05% C for CrMo and CSEF materials, and 0.04% C for austenitic stainless in this Table.

(4) Materials designed for temperatures below the creep range [see Note (2)] may be used without consideration of the WSRF or the rules of this Table. All other Code rules apply.

(5) Longitudinal seam welds in CrMo and CSEF materials shall be subjected to, and pass, a 100% volumetric examination (RT or UT). For materials other than CrMo and CSEF, see para. 123.4(B).

(6) At temperatures below those where WSRFs are tabulated, a value of 1.0 shall be used for the factor *W* where required by the rules of this Section. However, the additional rules of this Table and Notes do not apply.

(7) Norm. = normalizing postweld heat treatment (PWHT) is required.

(8) Basicity index of SAW flux ≥ 1.0.

(9) Sub Crit = subcritical PWHT is required. No exemptions from PWHT are permitted. The PWHT time and temperature shall meet the requirements of Table 132; the alternate PWHT requirements of Table 132.1 are not permitted.

(10) The CrMo steels include $^1\!/_2$Cr–$^1\!/_2$Mo, 1Cr–$^1\!/_2$Mo, 1$^1\!/_4$Cr–$^1\!/_2$Mo–Si, 2$^1\!/_4$Cr–1Mo, 3Cr–1Mo, and 5Cr–$^1\!/_2$Mo. Longitudinal welds shall either be normalized, normalized and tempered, or subjected to proper subcritical PWHT for the alloy.

(11) Longitudinal seam fusion welded construction is not permitted for C–$^1\!/_2$Mo steel for operation in the creep range [see Notes (2) and (4)].

(12) The CSEF (creep strength enhanced ferritic) steels include Grades 91, 92, 911, 122, and 23.

(13) N+T = normalizing + tempering PWHT.

(14) WSRFs have been assigned for austenitic stainless (including 800H and 800HT) longitudinally welded pipe up to 1,500°F as follows:

Temperature, °F	Temperature, °C	Weld Strength Reduction Factor
1,250	677	0.73
1,300	704	0.68
1,350	732	0.64
1,400	760	0.59
1,450	788	0.55
1,500	816	0.5

(15) Certain heats of the austenitic stainless steels, particularly for those grades whose creep strength is enhanced by the precipitation of temper-resistant carbides and carbo-nitrides, can suffer from an embrittlement condition in the weld heat affected zone that can lead to premature failure of welded components operating at elevated temperatures. A solution annealing heat treatment of the weld area mitigates this susceptibility.

(16) Autogenous SS welded pipe (without weld filler metal) has been assigned a WSRF up to 1,500°F of 1.00, provided that the product is solution annealed after welding and receives nondestructive electric examination, in accordance with the material specification.

(A.1.4) Where ends are subject to forming or machining for jointing, the wall thickness of the pipe, tube, or component after such forming or machining shall not be less than t_m minus the amount provided for removal by para. 104.1.2 (A.6.1).

(A.2) P = internal design pressure, psig [kPa (gage)]

NOTE: When computing the design pressure for a pipe of a definite minimum wall thickness by eq. (9) or (10), the value of P obtained by these formulas may be rounded out to the next higher unit of 10. For cast iron pipe, see para. 104.1.2(B).

(A.3) D_o = outside diameter of pipe, in. (mm). For design calculations, the outside diameter of pipe as given in tables of standards and specifications shall be used in obtaining the value of t_m. When calculating the allowable working pressure of pipe on hand or in stock, the actual measured outside diameter and actual measured minimum wall thickness at the thinner end of the pipe may be used to calculate this pressure.

(A.4) d = inside diameter of pipe, in. (mm). For design calculations, the inside diameter of pipe is the maximum possible value allowable under the purchase specification. When calculating the allowable working pressure of pipe on hand or in stock, the actual measured inside diameter and actual measured minimum wall thickness at the thinner end of the pipe may be used to calculate this pressure.

(A.5) SE or SF = maximum allowable stress in material due to internal pressure and joint efficiency (or casting quality factor) at the design temperature, psi (MPa). The value of SE or SF shall not exceed that given in Mandatory Appendix A, for the respective material and design temperature. These values include the weld joint efficiency, E, or the casting factor, F.

(A.6) A = additional thickness, in. (mm)

(A.6.1) To compensate for material removed in threading, grooving, etc., required to make a mechanical joint, refer to para. 102.4.2.

(A.6.2) To provide for mechanical strength of the pipe, refer to para. 102.4.4 (not intended to provide for extreme conditions of misapplied external loads or for mechanical abuse).

(A.6.3) To provide for corrosion and/or erosion, refer to para. 102.4.1.

(A.7) y = coefficient having values as given in Table 104.1.2(A)

(B) Thickness of gray and ductile iron fittings conveying liquids may be determined from ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. The thickness of ductile iron pipe may be determined by ANSI/AWWA C115/A21.15 or ANSI/AWWA C150/A21.50. These thicknesses include allowances for foundry tolerances and water hammer.

(C) While the thickness determined from eq. (7) or (8) is theoretically ample for both bursting pressure and material removed in threading, the following minimum requirements are mandatory to furnish added mechanical strength:

(C.1) Where steel pipe is threaded and used for steam service at pressure above 250 psi (1 750 kPa) or for water service above 100 psi (700 kPa) with water temperature above 220°F (105°C), the pipe shall be seamless having the minimum ultimate tensile strength of 48,000 psi (330 MPa) and a weight at least equal to Schedule 80 of ASME B36.10M.

(C.2) Where threaded brass or copper pipe is used for the services described in (C.1) above, it shall comply with pressure and temperature classifications permitted for these materials by other paragraphs of this Code and shall have a wall thickness at least equal to that specified above for steel pipe of corresponding size.

(C.3) Plain end nonferrous pipe or tube shall have minimum wall thicknesses as follows:

(C.3.1) For nominal sizes smaller than NPS $\frac{3}{4}$, the thickness shall not be less than that specified for Type K of ASTM B88.

(C.3.2) For nominal sizes NPS $\frac{3}{4}$ and larger, the wall thickness shall not be less than 0.049 in. (1.25 mm). The wall thickness shall be further increased, as required, in accordance with para. 102.4.

104.1.3 Straight Pipe Under External Pressure. For determining wall thickness and stiffening requirements for straight pipe under external pressure, the procedures outlined in UG-28, UG-29, and UG-30 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code shall be followed.

104.1.4 Longitudinal-Welded or Spiral-Welded Pipe Operating in the Creep Range. The minimum thickness of pipe wall required for design pressures and for temperature not exceeding that for the various materials listed in the Allowable Stress Tables shall not be less than that determined by eq. (11) or (12) as follows:

$$t_m = \frac{PD_o}{2(SEW + Py)} + A \tag{11}$$

$$t_m = \frac{Pd + 2SEWA + 2yPA}{2(SEW + Py - P)} \tag{12}$$

Piping Specification 400	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-400
Design Pressure (psig)	150
Design Temperature (°F)	250
Minimum Temperature (°F)	-20
Minimum Test Pressure (psig)	280
Maximum Test Pressure (psig)	295

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Category D
Material:	Copper
Pressure Rating:	150 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1, 3, 5-10, 20-24.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 4	Type L	ASTM B88	ASTM B88	Temper 050,060,H	Seamless
Tubing	¼ - 4	Type K	ASTM B88	ASTM B88	Temper 050,060,H	Seamless

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4
400	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070	0.080	0.090	0.100	0.110
Bend Radius			3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 125	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 4	Type L	ASME B16.18	ASTM B62	N/A	
Soldered Fittings	¼ - 4	Type L	ASME B16.22	ASME B16.22	N/A	
Flared Fittings	⅜ - 2	175 psig	ASME B16.26	ASTM B62	N/A	Max Temperature 100°
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 4	Class 150	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 4	Class 150	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅝	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1-HH	Refer to General Note 10.
Nuts	½ - ⅝	N/A	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 401	Date: September 17, 2014	Revision: 0	Page 1 of 1

DESIGN PARAMETERS

P-Spec	PS-401						
Design Pressure (psig)	225	225	210	195	180	165	130
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	340	400	395	365	345	370	390
Maximum Test Pressure (psig)	410						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	225 psi
External Pressure Rating:	N/A

GENERAL NOTES

Refer to General Notes 1, 3, 5-10, 21, 22, 24-26.

ALLOWABLE TUBE MATERIALS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 4	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless
Tubing	¼ - 4	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless

REQUIRED SCHEDULES FOR TUBE

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4
401	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070	0.080	0.090	0.100	0.110
Bend Radius			3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	5D	5D	-

FITTINGS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 125	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 4	Type L	ASME B16.18	ASTM B62	N/A	
Soldered Fittings	¼ - 4	Type L	ASME B16.22	ASME B16.22	N/A	
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

FLANGES

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 4	Class 150	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 4	Class 150	ASME B16.24	ASTM B62	N/A	

MECHANICAL FASTENERS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅝	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1-HH	Refer to General Note 10.
Nuts	½ - ⅝	N/A	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 402	Date: September 17, 2014	Revision: 0	Page 1 of 1

DESIGN PARAMETERS

P-Spec	PS-402						
Design Pressure (psig)	355	300	280	280	275	235	175
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	535	530	525	525	525	530	525
Maximum Test Pressure (psig)	560						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	355 psi
External Pressure Rating:	N/A

GENERAL NOTES

Refer to General Notes 1, 3, 5-10, 21, 22, 24-26.

ALLOWABLE TUBE MATERIALS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 2	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless
Tubing	¼ - 2	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless

REQUIRED SCHEDULES FOR TUBE

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2
402	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070
Bend Radius			3D	3D	3D	3D	3D	3D	5D	5D	-

FITTINGS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 2	Class 250	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 2	Type L	ASME B16.18	ASTM B62	N/A	Brazed
Soldered Fittings	¼ - 2	Type L	ASME B16.22	ASME B16.22	N/A	Brazed
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

FLANGES

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 2	Class 300	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 2	Class 300	ASME B16.24	ASTM B62	N/A	

MECHANICAL FASTENERS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1- HH	Min temperature - 325°F, See note 10
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A194	8F- HH	

Piping Specification 403	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-403						
Design Pressure (psig)	320	270	255	255	250	210	160
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	480	475	480	480	480	475	480
Maximum Test Pressure (psig)	495						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	400 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1, 3, 5-10, 21, 22, 24-27.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - ⅝	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless, Clean per ASTM B280
Tubing	¼ - 2	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless, Clean per ASTM B280

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2
403	0.00	Thickness	0.030	0.035	0.040	0.042	0.065	0.065	0.065	0.072	0.083
Bend Radius			3D	3D	3D	3D	1.5D	3D	3D	3D	5D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 2	Class 250	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 2	Type L	ASME B16.18	ASTM B62	N/A	Brazed
Soldered Fittings	⅛ - 2	Type L	ASME B16.22	ASME B16.22	N/A	Brazed
Flared Fittings	⅛ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200°
Tube Fittings	⅛ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 2	Class 300	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 2	Class 300	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1- HH	Min temperature - 325°F, See note 10
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A194	8F- HH	

Table of Contents

1.0 New Fabrication 1
2.0 DOT, IM, and UM Portable Tanks 2
3.0 Mobile Pressure Systems and Transport Tanks 4
4.0 Attachments 5
NASME-1-X B31.3 Equivalent Safety Evaluations 5
NASME-1-A Category D Non-Metallic Requirements 5
NASME-1-B Category Normal Fluids Non-Metallic Equivalency Evaluation 5
NASME-1-C Normal Fluids Equivalency Evaluation 5
NASME-1-D Category D Fluids Equivalency Evaluation 5
NASME-2 B31.9 Equivalent Safety Evaluations (future) 5

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Some material an update of Section I, Rev. 3 articles 14, 15, etc.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Note: This document is not to be used for new pressure systems that include boilers, pressure vessels, air receivers, or supporting piping (see Chapter 17 Section ASME), nor DOT, OSHA, etc. (see Section GEN).

Note: Piping that does not meet an attached equivalency evaluation must meet all Section ASME requirements (including but not limited to B31.3, B31.9, etc.)

1.0 NEW FABRICATION

A. Piping that is not part of a "supporting piping system" but is within the scope of B31.3 or B31.9 may apply the applicable, approved equivalency evaluations in the Attachments (*e.g., NASME-1, NASME -2*)

B. In order to be eligible for the attached equivalencies, the piping system cannot have a boiler, pressure vessel, or air receiver as part of the pressure system or be part of the supporting piping system.

From ESM Ch 17 Section GEN Attachment GEN-1 Definitions and Acronyms:

"Supporting piping systems" shall be considered any and or all the piping necessary for the function of the process or system for all pressure vessels, boilers, and air receivers. Piping that is attached in excess of that required for the process or system operation is not "supporting piping." For LANL, the system boundaries are defined by ESM Chapter 1, Section 220, and Chapter 1, Section 210, Attachment A. In practical applications to separate "supporting piping" from non-supporting piping, a unique pressure safety system identification number in accordance with ESM Chapter 17 will be used to identify piping that is considered to be non-supporting piping. All pressure systems are required to meet the requirements of ESM Chapter 17.

2.0 DOT, IM, AND UM PORTABLE TANKS

A. Special Instructions for DOT-4L Cylinders[1]

WARNING: A cylinder used for CO_2 service must remain CO_2 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
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_2) 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, <u>but does not contain all the requirements of the CFR. The system owner is advised to carefully review the applicable sections</u>.

[1] Chart Industries, Inc., "Liquid Cylinder" Users Manual P/N 10642912 Date:12/00

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.		

4. 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.[2]

[2] 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.		

3.0 MOBILE PRESSURE SYSTEMS AND TRANSPORT TANKS

A. Definitions

1. LANL-owned mobile pressure vessels and tanks [Category 406 (4 psi)] are subject to the requirements of this document. These systems and vessels include, but are not limited, to the following:

   a. ASME Section XII vessels

   b. Portable tanks for transporting cryogenic fluids (greater than 120 gallons), not part of a Road-Tank vehicle.

   c. Rail Tanks

   d. 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.

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 code stamped relief devices (UV) or (UD). ASME Section VIII stamped components are authorized to be used on (U) stamped vessels provided the requirements of Section XII are met as defined in ASME Section XII, Article TG-120.2.
3. Must comply with the re-test/replace intervals, as specified in this Chapter.

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 Required Initial Contents

1. The manufacturer's data report (T-1A, B, or C) and/or partial data report.
2. Relief valve calculations, recall date, and set pressure.

F. Repairs and Alterations

1. Must be performed by an institution holding the (TR) stamp, in accordance with NBIC/NB-23, and as defined in ASME Section XII Part TP.
2. Must be documented and maintained in the pressure system documentation package.

G. Tests and Inspections

1. Testing and inspection must be performed as defined in ASME Section XII, Articles TP-4 and TP-5.
2. Records of inspections must be maintained in the pressure system documentation package as defined in ASME Section XII, Article TP-6.

4.0 ATTACHMENTS

NASME-1-X B31.3 Equivalent Safety Evaluations
- NASME-1-A Category D Non-Metallic Requirements
- NASME-1-B Category Normal Fluids Non-Metallic Equivalency Evaluation
- NASME-1-C Normal Fluids Equivalency Evaluation
- NASME-1-D Category D Fluids Equivalency Evaluation

NASME-2 B31.9 Equivalent Safety Evaluations (future)

Attachment NASME-1-A: Equivalent Safety Evaluation for Category D Non-Metallic Requirements for Piping not Associated with Pressure Vessel, Boilers, or Air Receivers (B31.3-2010, 2012, and 2014)

RECORD OF REVISION

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	6/30/15	A342 changed to use B31.3 paragraph as written. A345 added requirement based on ASME interpretation. Updates for B31.3-2014.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This evaluation of risk is per Chapter 17, Section EXIST-1 (Qualitative Risk greater than 3)

1. Applicable for B31.3 piping not including a pressure vessel, boiler, air receiver, or supporting piping.
2. Applicable only for NON - metallic piping systems.
3. This evaluation is for new pressure systems that allow workers to be in close proximity without additional shielding while the system is pressurized.
4. For severely cyclic system see specific code requirements.
5. A list of reputable manufacturers will be maintained by Engineering Services.
6. The “Equivalent Risk Evaluation” in the table below or the original paragraph in B31.3 may be followed. The equivalency is intended to provide an equivalent level of personnel safety to B31.3, not code compliance.
7. Applies to ML-4 only.

<table>
<tr><th>Paragraph</th><th>Category D Fluid Service Non Metallic
Equivalency Evaluation
(Within the allowance of notes above this table)</th></tr>
<tr><td colspan="2">Title: Scope and Definitions</td></tr>
<tr><td>A300 General Statements (b) Responsibilities</td><td>System Owner designs system, but must be approved by PSO B for safety check.

Training will be developed for System Owners to perform pressure system designs. In the interim until the training is developed and implemented, system owners with PSO assistance and concurrence may serve as designers.

PSO Duty Area B may perform the role as Owner’s Inspector.</td></tr>
<tr><td>300.1.3 Exclusions</td><td>Pressure systems will be inventoried with a system identification tag as defined in Section ADMIN-1. Those pressure systems that are excluded from B31.3 scope shall be declared Section GEN Att GEN-2 as follows:

B31.3 excludes pressure systems if less than 15 psig, nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) B31 series does not apply.

LANL pressure systems where the supply pressure is greater than 15 psig but have a relief device proven adequate to protect the system from over pressurization by calculation or flow testing to less than 15 psig, and is nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) are excluded.

In order to maintain the LANL pressure system inventory a system identification tag shall be applied in accordance with ESM Chapter 17, Section 8.0, System Identification Tag, with the word Exempt on the tag.

The regulator and relief device must be close coupled with no intervening stop valves and identified in accordance with ESM Chapter 17 requirements.

A copy of a simplified system sketch and the documentation showing the system is adequately protected against overpressure shall be maintained as records, and must be managed per LANL P 1020, P 1020-1, and P 1020-2.

Relief device retest frequency is a 5 year interval.</td></tr>
<tr><td>300.2 Definitions</td><td>This table is <u>not</u> applicable to for Category M Fluid Service, Elevated Temperature Fluid Service, High Pressure Fluid Service, or High Purity Fluid Service (reference Section II Attachment II-3 for Category M fluids; contact the CPSO for other fluids not listed)

Flammability limits are per Compressed Gas Association (CGA) P-23 (NFPA 55)

Determination of flammability limit is per American Society for Testing and Materials (ASTM) E681-85, Standard Test Method for Concentration Limits of Flammability of Chemicals,</td></tr>
</table>

Title: Design	
A301.1 Qualifications of the Designer	See above 300 General Statements (b) Responsibilities
A301.2.2 Required Pressure Containment or Relief	As written for Category D Fluid Service., but using manufacturers' published rating for design pressure. Or protect personnel using other controls; engineering, administrative, and/or PPE as approved by the PSO as per ASME B&PVC Section VIII Div. 1 UG-140 "OVERPRESSURE PROTECTION BY SYSTEM DESIGN "
A301.3 Design Temperature	This paragraph does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change).
A301.3.1 Design Minimum Temperature	Lowest allowable minimum design temperature is -20 F (-29 C).
A301.4 Ambient Effects	Does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and ambient temperature is less than 120 degree F.
A301.5 Dynamic Effects	Impact, wind, earthquake, vibration, discharge reactions are required to be evaluated and discounted or applied.
A301.6 Weight Effects	Live and dead loads are required to be evaluated and discounted or applied.
A301.7 Thermal Expansion and Contraction Effects	Normally does not apply to pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change) Applies to pressure systems with appreciable thermal expansion or phase change induced volumetric expansion (increases of specific volume).
A301.8 Effects of Support, Anchor, and Terminal Movements	Restraints do not apply for whip hazard.
A301.9 Reduced Ductility Effects	Not applicable
302 Design Criteria	Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A302.2.1 Listed Components Having Established Ratings	Listed items are recommended, but manufacturer's published ratings are acceptable.

A302.2.2 Listed Components Not Having Specific Ratings	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain by Engineering Services. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
A302.2.3 Unlisted Components	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain on the Engineering Services.
A302.3 Allowable Stresses and Other Stress Limits	Per design may consider other protective measures in order of precedence as follows: engineering controls (barriers, interlocks or controls), procedural controls (access control), and/or PPE.
A302.3.3 Limits of Calculated Stresses Due to Sustained Loads	Use B31.3 paragraph as written if applicable Note: It is recommended that external loads be supported independent from the piping system.
A302.3.4 Limits of Calculated Stresses Due to Occasional Loads	Use B31.3 paragraph as written if applicable
A302.4 Allowances	Fluid will be evaluated and determined to be compatible for the service life of the system with the materials of construction and manufacturer's recommendations.
A304 PRESSURE DESIGN OF COMPONENTS A304.1 Straight Pipe	If LANL is designing or having a design made for a pressure component, the design shall comply with paragraph A304.1. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.2 Curved and Mitered Segments of Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.2 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.3 Branch Connections	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.3 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.

A304.4 Closures	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.4 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.5 Pressure Design of Nonmetallic Flanges and Blanks	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.5 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.6 Reducers	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.6 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.7 Pressure Design of Other Components	Initial design consistent with the design criteria of ASME B31.3 shall be a hoop stress evaluation at the minimum wall thickness at the maximum part diameter (worst case hoop stress) showing the design meets or exceed the stress. Note use B31.3 allowable stress values with B31.3 equations. Substantiation of the above may be done by one of the 4 items below: Note: System design pressure may be used to evaluate the component as the design pressure 1) For a simple part that has no stress intensification factors (notches, threads, pits, cracks, etc..) the minimum calculated hoop stress shall be 4x the design pressure (MAWP) 2) Determine if the piping component was previously used in accordance with paragraph A304.7.2 (a) 3) Pressure test to 4x the design pressure (at maximum design temperature). 4) Perform Engineering Finite Analysis (FEA) in accordance with paragraph 304.7.2 (d).
A305 Pipe	Paragraph is required to be evaluated and discounted or applied

A306 FITTINGS, BENDS, MITERS, LAPS, AND BRANCH CONNECTIONS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A306. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A307 VALVES AND SPECIALTY COMPONENTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A307. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A308 FLANGES, BLANKS, FLANGE FACINGS, AND GASKETS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A308. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A309 BOLTING	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A309. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A310 GENERAL	Use B31.3 paragraph as written.
A311 Bonded Joints in Plastic	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE* [Non-destructive examinations (NDE)]. Note: Qualitative Risk evaluated per ESM Chapter 17 Att GEN-4 shall be controlled to QR number of 4 or higher per Table GEN-4-4, Qualitative Risk (QR) Determination Follow manufacturers' instructions for assembly of PVC solvent welded joints.
A311.2 Specific Requirements	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE*.

A312 Flanged Joints	Use B31.3 paragraph as written for Category D Fluid Service: “The designer should consult the manufacturer for ratings of flanged joints in nonmetallic piping and in piping lined with nonmetals.”
A313 Expanded Joints	Use B31.3 paragraph as written for Category D Fluid Service
A314 Threaded Joints	Use B31.3 paragraph as written for Category D Fluid Service
A315 Tubing Joint	Use B31.3 paragraph as written for Category D Fluid Service
A316 CAULKED JOINTS	Use B31.3 paragraph as written for Category D Fluid Service.
A318 Special Joints	As written for Category D Fluid Service, and evaluate in accordance with A304.7.2 in this table. NOTE: Gland here does not mean Swagelok gland fitting.
A319 Piping Flexibility	The design temperature is from −29°C (−20°F) through 186°C (366°F) Paragraph is required to be evaluated and discounted or applied When pressure systems are fabricated and used at relatively constant temperature conditions (+/- 10 F), and fluid temperature is also held within the same range this paragraph is satisfied.
A320 Analysis of Sustained Loads	Piping is not to be used to support equipment (not a piping component). Paragraph is required to be evaluated and discounted or applied. Piping supports may be in accordance with LANL Master Specification 22 0529 for all Category D Fluid Service pressures. If additional support is required see 321.
A321 Piping Supports	Use B31.3 paragraph as written in 321.1.2 “simple calculations and engineering judgment”
A322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written.
A322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written Pressure systems with vessels, air receivers or boilers require an ASME Stamped and approved relief device protecting the vessel, air receiver, or boiler. Existing piping relief devices may be used if they are stamped and the vessel cannot be pressurized through any other path or means. Piping relief is not required to be V stamped if no code stamped item (pressure vessel, boiler, or air receiver) is present.

<table>
<tr><th colspan="2">Title: Materials</th></tr>
<tr><td>A323 GENERAL REQUIREMENTS</td><td>Use listed materials for example:
<table>
<tr><td>Acrylonitrile-butadiene-styrene plastics</td><td>ABS</td></tr>
<tr><td>Chlorinated poly(vinyl chloride)</td><td>CPVC</td></tr>
<tr><td>Perfluoro (alkoxyalkane)</td><td>PFA</td></tr>
<tr><td>Polypropylene PP, Poly(vinyl chloride)</td><td>PVC</td></tr>
<tr><td>Poly (vinylidene chloride)</td><td>PVDC</td></tr>
<tr><td>Poly (vinylidene fluoride)</td><td>PVDF</td></tr>
<tr><td>Polytetrafluoroethylene</td><td>PTFE</td></tr>
</table>
Additional listed materials are in B31.3 Appendix B.
This evaluation does not apply to Test Articles.</td></tr>
<tr><td>A323.1.1 Listed Materials.</td><td>Use B31.3 paragraph as written.</td></tr>
<tr><td>A323.1.2 Unlisted Materials</td><td>Prior to using an unlisted material the chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control must be known as required by A323.1.
Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer’s published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the application and must be evaluated in accordance with A323.1 if necessary to determine the suitability of the material.</td></tr>
<tr><td>A323.1.3 Unknown Materials</td><td>Don’t use unknown materials.</td></tr>
<tr><td>A323.1.4 Reclaimed Materials.</td><td>Use B31.3 paragraph as written.</td></tr>
<tr><td>A323.2 Temperature Limitations</td><td>Note: The minimum [−29°C (−20°F)] and maximum temperature as shown in the definition of Category D Fluid Service does not necessarily apply, and must be verified as required by A323.2</td></tr>
<tr><td>A323.2.1 Upper Temperature Limits, Listed Materials</td><td>Materials shall have test results or manufacturers supplied data at or above the highest expected service temperature.</td></tr>
</table>

A323.2.2 Lower Temperature Limits, Listed Materials	Materials shall have test results or manufacturers supplied data at or below the lowest expected service temperature.
A323.2.3 Temperature Limits, Unlisted Materials	Use B31.3 paragraph as written. To verify the temperature limits of the unlisted material meet the requirements of the design temperature. Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the temperature and must be evaluated in accordance with 323.2.3 if necessary to determine the suitability of the material.
A323.2.4 Verification of Serviceability	Use B31.3 paragraph as written.
A323.4 Fluid Service Requirements for Non-Metallic Materials	Use B31.3 paragraph as written.
A323.5 Deterioration of Materials in Service	Designer is required to design the pressure system for the service life of the system and consider material compatibility.
A325 MATERIALS — MISCELLANEOUS	Use B31.3 paragraph as written.
326 DIMENSIONS AND RATINGS OF COMPONENTS	Use components as defined in the code or use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintained on the Engineer Services website. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
A326.1 Dimensional Requirements	Apply B31.3 paragraph as written (see A301.2.2)
A326.4 Abbreviations in Table A326.1 and Appendix B	Apply B31.3 paragraph as written
A327 GENERAL	Use B31.3 paragraph as written.
A328 BONDING OF PLASTICS	Not required for a low risk pressure system (ESM Chapter 17 Pressure Safety, Table E-3 Qualitative Risk (greater than 3))

A329 FABRICATION OF PIPING LINED WITH NONMETALS	Apply B31.3 paragraph as written (see A301.2.2), or as per the variance VAR-2013-060 B31.3 – 2010 & 2012 Category D Requirements
A332 BENDING AND FORMING	Apply B31.3 paragraph as written (see A301.2.2), or as per the variance VAR-2013-060 B31.3 – 2010 & 2012 Category D Requirements
A334 JOINING NONPLASTIC PIPING	Use B31.3 paragraph as written.
A335 ASSEMBLY AND ERECTION	Assemble in accordance with the manufacturer's requirements
A340 INSPECTION 340.1 General	Paragraph 340 applies in its entirety. PSO Duty Area B will be the Owner's Inspector Owner's Inspector will be knowledgeable with the pressure system of interest.
340.2 Responsibility for Inspection	Use B31.3 paragraph as written.
340.3 Rights of the Owner's Inspector	Use B31.3 paragraph as written.
340.4 Qualifications of the Owner's Inspector	See paragraph 300; PSO Duty Area B will act as the Owner's Inspector or equivalent.
A341 EXAMINATION	Use B31.3 paragraph as written.
A342 Examination Personnel	Use B31.3 paragraph as written.
A343 Examination Procedures	Use B31.3 paragraph as written.
A344 Types of Examination	Use B31.3 paragraph as written.

A345 TESTING	Precautions in Appendix F, para. FA323.4 Material Considerations — Nonmetals should be considered. Owner has elected to use Initial Service Leak Test for Category D Fluid Service (additional testing may be required by the Designer). Pneumatic leak testing is approved for all systems less than 2 cubic feet in volume. Additional volume must be approved by the CPSO. [1] See Exist – Legacy System Requirements (*3.B.1*) for vacuum rate of rise and inert gas referee test gas. See A345 for other requirements for example test pressures (A345.4.2), test limitations (A345.2.1), and other requirements for pneumatic testing (A345.5.2) Note: Be aware of the ramifications of using high molecular weight gases to test system for lower molecular weight gas. The engineering best practice is to use a lower or equal weight molecular weight gas as the referee test gas except for hydrogen where helium is accepted.
A346 RECORDS	Required information is as follows: • Sketch, • Component list (manufacturer, model number, pressure rating, FM07 information) • Calculation • Relief device/flow calc. • Examinations • Inspections Electronic copy loaded into a master site repository.

[1] EMRef-73 ASME Interpretation of Para. 345.5.5 Pneumatic Leak Test Procedure

NASME-1-B: Equivalent Safety Evaluation for Category Normal Non-Metallic Requirements for Piping not Associated with Pressure Vessel, Boilers, or Air Receivers

(B31.3-2010, 2012, and 2014)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	6/30/15	A342 changed to use B31.3 paragraph as written. A345 added requirement based on ASME interpretation. Updates for B31.3-2014.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This evaluation of risk is per Chapter 17 Section EXIST-1 (Qualitative Risk greater than 3).

1. Applicable for B31.3 piping not including a pressure vessel, boiler, air receiver, or supporting piping.
2. This evaluation is for new pressure systems that allow workers to be in close proximity without additional shielding while the system is pressurized.
3. For severely cyclic system see specific code requirements.
4. Applicable only for NON - metallic piping systems.
5. A list of reputable manufacturers will be maintained by Engineering Services.
6. The “Equivalent Risk Evaluation” in the table below or the original paragraph in B31.3 may be followed. The equivalency is intended to provide an equivalent level of personnel safety to B31.3 not code compliance.
7. Applies to ML-4 only.

<table>
<tr><th>Paragraph</th><th>Normal Fluid Service Non Metallic
Equivalency Evaluation
(within the allowance of notes above this table)</th></tr>
<tr><td colspan="2">Title: Scope and Definitions</td></tr>
<tr><td>A300 GENERAL STATEMENTS
(b) Responsibilities</td><td>System Owner designs system, but must be approved by PSO B for safety check.

Training will be developed for System Owners to perform pressure system designs. In the interim until the training is developed and implemented, system owners with PSO assistance and concurrence may serve as designers.

PSO Duty Area B may perform the role of Owner’s Inspector.</td></tr>
<tr><td>300.1.3 Exclusions (referenced from A300 General Statements (f))</td><td>Pressure systems will be inventoried with a system identification tag as defined in ESM Chapter 17. Those pressure systems that are excluded from B31.3 scope shall be declared exempt as defined Section GEN-2 as follows:
B31.3 excludes pressure systems if less than 15 psig, nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) B31 series does not apply.

LANL pressure systems where the supply pressure is greater than 15 psig but have a relief device proven adequate to protect the system from over pressurization by calculation or flow testing to less than 15 psig, and is nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) are excluded.

In order to maintain the LANL pressure system inventory a system identification tag shall be applied in accordance with ESM Chapter 17, Section ADMIN, System Identification Tag, with the word Exempt on the tag.

The regulator and relief device must be close coupled with no intervening stop valves and identified in accordance with ESM Chapter 17 requirements.

A copy of a simplified system sketch and the documentation showing the system is adequately protected against overpressure shall be maintained as records, and must be managed per LANL P 1020, P 1020-1, and P 1020-2.

Relief device retest frequency is a 5-year interval.</td></tr>
<tr><td>300.2 Definitions (referenced from A300 General Statements (f))</td><td>This table is <u>not</u> applicable to for Category M Fluid Service, Elevated Temperature Fluid Service, High Pressure Fluid Service, or High Purity Fluid Service (reference Section II Attachment II-3 for Category M fluids , contact the CPSO for other fluids not listed)</td></tr>
</table>

	Flammability limits are per Compressed Gas Association (CGA) P-23 (NFPA 55) Determination of flammability limit is per American Society for Testing and Materials (ASTM) E681-85, *Standard Test Method for Concentration Limits of Flammability of Chemicals*,
Title: Design	
301.1 Qualifications of the Designer (referenced from A301)	See above 300 General Statements (b) Responsibilities
301.2.2 Required Pressure Containment or Relief (referenced from A302)	As written for Normal Fluid Service, but using manufacturers' published rating for design pressure. Or protect personnel using other controls; engineering, administrative, and/or PPE as approved by the PSO as per ASME B&PVC Section VIII Div. 1 UG-140 "OVERPRESSURE PROTECTION BY SYSTEM DESIGN "
A301.3 Design Temperature	This paragraph does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change).
A301.3.1 Design Minimum Temperature	Minimum design temperature is a function of the material and the lower allowable temperatures in Table B-1. Note: Non-metallic materials exhibit a "glass transition temperature" where the material becomes hard and may be susceptible to brittle fracture.
301.4 Ambient Effects (referenced from A301)	Does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and ambient temperature is less than 120 degree F.
301.5 Dynamic Effects (referenced from A301)	Impact, wind, earthquake, vibration, discharge reactions are required to be evaluated and discounted or applied.
301.6 Weight Effects (referenced from A301)	Live and dead loads are required to be evaluated and discounted or applied.
301.7 Thermal Expansion and Contraction Effects (referenced from A301)	This paragraph normally does not apply to if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change) Applies to pressure systems with appreciable thermal expansion or phase change induced volumetric expansion (increases of specific volume).
301.8 Effects of Support, Anchor, and Terminal Movements (referenced from A301)	This paragraph does not apply to restraints for whip hazard.

301.9 Reduced Ductility Effects (referenced from A301)	Not applicable
301.10 Cyclic Effects (referenced from A301)	Not applicable
301.11 Air Condensation Effects (referenced from A301)	Required to be evaluated and discounted or applied
A302 Design Criteria	Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A302.1 General	Required to be evaluated and discounted or applied
A302.2.1 Listed Components Having Established Ratings	Use listed component if available, but if none are available manufacturer's ratings are acceptable for the service conditions temperature, pressure, compatibility, etc….
A302.2.2 Listed Components Not Having Specific Ratings	First use reputable manufacturers ratings for the service conditions (IESL, or add listing of example suppliers as attachment to web page.) If none are available establish a rating for the service conditions temperature, pressure, compatibility, etc… as approved by the PSO. NOTE: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers
A302.2.3 Unlisted Components	First use reputable manufacturers ratings for the service conditions (IESL, or add listing of example suppliers as attachment to web page.) If none are available establish a rating for the service conditions temperature, pressure, compatibility, etc… as approved by the PSO.
A302.2.4	Required to be evaluated and discounted or applied
A302.2.5	Apply paragraph as written
A302.3 Allowable Stresses and Other Design Limits	Per design may consider other protective measures in order of precedence as follows: engineering controls (barriers, interlocks or controls), procedural controls (access control), and/or PPE.
A302.3.3 Limits of Calculated Stresses Due to Sustained Loads	Use B31.3 paragraph as written if applicable Note: It is recommended that external loads be supported independent from the piping system.
A302.3.4 Limits of Calculated Stresses Due to Occasional Loads	Use B31.3 paragraph as written if applicable
302.4 Allowances (referenced from A302.4)	Fluid will be evaluated and determined to be compatible for the service life of the system with the materials of construction and

	manufacturer's recommendations or allowances must be added in accordance with the paragraph.
Pressure Design of Piping Components A303 GENERAL	Use B31.3 paragraph as written
A304 PRESSURE DESIGN OF COMPONENTS A304.1 Straight Pipe	All LANL designs or designs for LANL shall comply with para A304. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). (if using reputable manufacturer's published ratings this Part 2 does not apply) Or protect personnel using other controls; engineering, administrative, and/or PPE as approved by the PSO.
A304.2 Curved and Mitered Segments of Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.2 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.3 Branch Connections	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.3 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.3.1 General	Required to be evaluated and discounted or applied
A304.3.2 Branch Connections Using Fittings	Required to be evaluated and discounted or applied
A304.3.3 Additional Design Considerations	Required to be evaluated and discounted or applied
A304.4 Closures	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.4 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.5 Pressure Design of Nonmetallic Flanges	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.5 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material).

	Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.6 Reducers	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A304.6 The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table B1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A304.7 Pressure Design of Other Components	Initial design consistent with the design criteria of ASME B31.3 shall be a hoop stress evaluation at the minimum wall thickness at the maximum part diameter (worst case hoop stress) showing the design meets or exceed the stress. Note use B31.3 allowable stress values with B31.3 equations. Substantiation of the above may be done by one of the 4 items below: Note: System design pressure may be used to evaluate the component as the design pressure 1) For a simple part that has no stress intensification factors (notches, threads, pits, cracks, etc..) the minimum calculated hoop stress shall be 4x the design pressure (MAWP) 2) Determine if the piping component was previously used in accordance with paragraph A304.7.2 (a) 3) Pressure test to 4x the design pressure (at maximum design temperature). 4) Perform Engineering Finite Analysis (FEA) in accordance with paragraph 304.7.2 (d).
A305 Pipe	Paragraph is required to be evaluated and discounted or applied
A306 FITTINGS, BENDS, MITERS, LAPS, AND BRANCH CONNECTIONS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A306. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A307 VALVES AND SPECIALTY COMPONENTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A307. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A308 FLANGES, BLANKS, FLANGE FACINGS, AND	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A308. The material shall

GASKETS	meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A309 BOLTING	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph A309. The material shall meet A323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
A310 GENERAL	Use B31.3 paragraph as written.
311 BONDED JOINTS IN PLASTICS	Welding shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE* [Non-destructive examinations (NDE)]. Use B31.3 paragraph as written.
A312 FLANGED JOINTS	Use B31.3 paragraph as written for Normal Fluid Service: "The designer should consult the manufacturer for ratings of flanged joints in nonmetallic piping and in piping lined with nonmetals."
A313 EXPANDED JOINTS	Use B31.3 paragraph as written for Normal Fluid Service
A314 THREADED JOINTS	Use B31.3 paragraph as written for Normal Fluid Service
A315 TUBING JOINT	Use B31.3 paragraph as written for Normal Fluid Service.
A316 CAULKED JOINTS	Use B31.3 paragraph as written for Normal Fluid Service.
A318 SPECIAL JOINTS	As written for Normal Fluid Service, and evaluate in accordance with A304.7.2 in this table. NOTE: Gland here does not mean Swagelok gland fitting.
A319 FLEXIBILITY AND NONMETALLIC PIPING	Paragraph is required to be evaluated and discounted or applied When pressure systems are fabricated and used at relatively constant temperature conditions (+/- 10 F), and fluid temperature is also held within the same range this paragraph is satisfied.
A321 PIPING SUPPORTS	Use B31.3 paragraph as written and reference 321.1.2 "simple calculations and engineering judgment"
A322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written Pressure systems with vessels, air receivers or boilers require an ASME Stamped and approved relief device protecting the vessel, air receiver, or boiler. Existing piping relief devices may be used if they are stamped and

	the vessel cannot be pressurized through any other path or means. Piping relief is not required to be V stamped if no code stamped item (pressure vessel, boiler, or air receiver) is present.

Title: Materials	
A323 GENERAL REQUIREMENTS	Use listed materials for example: Acrylonitrile-butadiene-styrene plastics — ABS Chlorinated poly(vinyl chloride) — CPVC Perfluoro (alkoxyalkane) — PFA Polypropylene PP, Poly(vinyl chloride) — PVC Poly(vinylidene chloride) — PVDC Poly(vinylidene fluoride) — PVDF Polytetrafluoroethylene — PTFE Additional listed materials are in B31.3 Appendix B. This evaluation does not apply to Test Articles.
323.1. Listed Materials.(referenced from A323.1 Materials and Specifications)	Use B31.3 paragraph as written.
323.1.2 Unlisted Materials (referenced from A323.1 Materials and Specifications)	Prior to using an unlisted material the chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control must be known as required by 323.1.2 (referenced from A323.1). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the application and must be evaluated in accordance with A323.1 if necessary to determine the suitability of the material.
A323.1.3 Unknown Materials.(referenced from A323.1 Materials and Specifications)	Don't use unknown materials.
A323.1.4 Reclaimed Materials.	Use B31.3 paragraph as written.

A323.2 Temperature Limitations	Use B31.3 paragraph as written.
A323.2.1 Upper Temperature Limits, Listed Materials	Materials shall have test results or manufacturers supplied data at or above the highest expected design temperature.
A323.2.2 Lower Temperature Limits, Listed Materials	Materials shall have test results or manufacturers supplied data at or below the lowest expected design temperature. Note: Non-metallic materials exhibit a "glass transition temperature" where the material becomes hard and may be susceptible to brittle fracture.
A323.2.3 Temperature Limits, Unlisted Materials.	Use B31.3 paragraph as written. To verify the temperature limits of the unlisted material meet the requirements of the design temperature. Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the temperature and must be evaluated in accordance with 323.2.3 (referenced by A323.2.3) 3 if necessary to determine the suitability of the material.
A323.2.4 Verification of Serviceability	Use B31.3 paragraph as written.
A323.4 Fluid Service Requirements for Non-Metallic Materials 323.4.1 General	Use B31.3 paragraph as written.
A323.4.2 Specific Requirements	Use B31.3 paragraph as written.
A323.4.3 Piping Lined With Nonmetals	Use B31.3 paragraph as written.
A323.5 Deterioration of Materials in Service	Designer is required to design the pressure system for the service life of the system and consider material compatibility.
A325 MATERIALS MISCELLANEOUS	Use B31.3 paragraph as written.

Title: Standards for Piping Components	
326 DIMENSIONS AND RATINGS OF COMPONENTS	Use components as defined in the code or use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintained on the Engineer Services website. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.

A326.1 Dimensional Requirements	Apply B31.3 paragraph as written (see A301.2.2)
A326.4 Abbreviations in Table A326.1 and Appendix B	Apply B31.3 paragraph as written

Title: Fabrication, Assembly, and Erection	
A327 GENERAL	Use B31.3 paragraph as written.
A328 BONDING OF PLASTICS	Not required for a low risk pressure system (ESM Chapter 17, GEN-4, Qualitative Risk (greater than 3))
A329 FABRICATION OF PIPING LINED WITH NONMETALS	Apply B31.3 paragraph as written (see A301.2.2), or as per the variance VAR-2013-060 B31.3 – 2010 & 2012 Normal Requirements
A332 BENDING AND FORMING	Apply B31.3 paragraph as written (see A301.2.2), or as per the variance VAR-2013-060 B31.3 – 2010 & 2012 Normal Requirements
A334 JOINING NONPLASTIC PIPING	Use B31.3 paragraph as written.
A335 ASSEMBLY AND ERECTION	Assemble in accordance with the manufacturer's requirements

Title: Inspection, Examination, and Testing	
A340 INSPECTION	Paragraph A340 applies in its entirety. PSO Duty Area B will be the Owner's Inspector Owner's Inspector will be knowledgeable with the pressure system of interest.
340.2 Responsibility for Inspection (referenced by A340)	Use B31.3 paragraph as written.
340.3 Rights of the Owner's Inspector (referenced by A340)	Use B31.3 paragraph as written.
340.4 Qualifications of the Owner's Inspector (referenced by A340)	See paragraph 300; PSO Duty Area B will act as the Owner's Inspector or equivalent.
A341 EXAMINATION	Use B31.3 paragraph as written.
A342 EXAMINATION PERSONNEL	Use B31.3 paragraph as written.
A343 EXAMINATION PROCEDURES	Use B31.3 paragraph as written.

A344 TYPES OF EXAMINATION	Use B31.3 paragraph as written.
A345 TESTING	Precautions in Appendix F, para. FA323.4 Material Considerations — Nonmetals should be considered. The Owner accepts pneumatic or hydro-pneumatic leak testing with inert gas or air (additional testing may be required by the Designer). See Exist – Legacy System Requirements (*3.B.1*) for vacuum rate of rise and inert gas referee test gas. Pneumatic leak testing is approved for all systems less than 2 cubic feet in volume. Additional volume must be approved by the CPSO. [1] See A345 for other requirements for example test pressures (A345.4.2), test limitations (A345.2.1), and other requirements for pneumatic testing (A345.5.2) Note: Be aware of the ramifications of using high molecular weight gases to test system for lower molecular weight gas. The engineering best practice is to use a lower or equal weight molecular weight gas as the referee test gas except for hydrogen where helium is accepted.
A346 RECORDS	Required information is as follows: • Sketch, • Component list (manufacturer, model number, pressure rating, FM07 information) • Calculation • Relief device/flow calc. • Examinations • Inspections Electronic copy loaded into a master site repository.

[1] EMRef-73 ASME Interpretation of Para. 345.5.5 Pneumatic Leak Test Procedure.

NASME-1-C: Equivalency Evaluation to Normal Fluid Service for Metallic Piping Not Associated with Pressure Vessel, Boilers, or Air Receivers

(B31.3-2010, 2012, and 2014)

RECORD OF REVISION

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	6/30/15	A342 changed to Use B31.3 paragraph as written. A345 change based on ASME interpretation. Updates for B31.3-2014.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This evaluation of risk is per Chapter 17, Section EXIST-1 (Qualitative Risk greater than 3).

1. Applicable for B31.3 piping not including a pressure vessel, boiler, air receiver, or supporting piping.
2. This evaluation is for new pressure systems that allow workers to be in close proximity without additional shielding while the system is pressurized.
3. For severely cyclic system see specific code requirements.
4. Applicable only for metallic piping systems.
5. For Elevated Temperature Fluid Service (temperature in creep range) see specific code requirements.
6. A list of reputable manufacturers will be maintained by Engineering Services
7. The “Equivalency Evaluation” in the table below or the original paragraph in B31.3 may be followed. The equivalency is intended to provide an equivalent level of personnel safety to B31.3, not code compliance.

B31.3 Paragraph	Equivalency Evaluation (within the allowance of notes above this table)
Title: Scope and Definitions	
300 GENERAL STATEMENTS (B) RESPONSIBILITIES	System Owner designs system, but must be approved by PSO B for safety check. Training will be developed for System Owners to perform pressure system designs. In the interim until the training is developed and implemented, system owners with PSO assistance and concurrence may serve as designers.) PSO Duty Area B may perform the role of Owner's Inspector.
300.1.3 Exclusions	Pressure systems will be inventoried with a system identification tag as defined in ESM Chapter 17. Those pressure systems that are excluded from B31.3 scope shall be declared exempt as defined in Section GEN as follows: B31.3 excludes pressure systems if less than 15 psig, nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) B31 series does not apply. LANL pressure systems where the supply pressure is greater than 15 psig but have a relief device proven adequate to protect the system from over pressurization by calculation or flow testing to less than 15 psig, and is non-flammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) are excluded. In order to maintain the LANL pressure system inventory a system identification tag shall be applied in accordance with ESM Chapter 17, Section ADMIN, *System Identification Tag*, with the word Exempt on the tag. The regulator and relief device must be close coupled with no intervening stop valves and identified in accordance with ESM Chapter 17 requirements. A copy of a simplified system sketch and the documentation showing the system is adequately protected against overpressure shall be maintained as records, and must be managed per LANL P 1020, P 1020-1, and P 1020-2. Relief device retest frequency is a 5 year interval.
300.2 Definitions	This table is **not** applicable to for Category D Fluid Service, Category M Fluid Service, Elevated Temperature Fluid Service, High Pressure Fluid Service, or High Purity Fluid Service (reference Chapter 17 Section II Attachment II-3 for Category M fluids; contact the CPSO for fluids not listed) Flammability limits are per Compressed Gas Association (CGA) P-23 (NFPA 55) Determination of flammability limit is per ASTM E681-85, *Standard Test Method for Concentration Limits of Flammability of Chemicals*.

Title: **Design**	
301.1 Qualifications of the Designer	See above 300 General Statements (b) Responsibilities
301.2.2 Required Pressure Containment or Relief	As written for Normal Fluid Service, but using manufacturers' published rating for design pressure. Or protect personnel using other controls; engineering, administrative, and/or PPE as approved by the PSO as per ASME B&PVC Section VIII Div. 1 UG-140 "OVERPRESSURE PROTECTION BY SYSTEM DESIGN "
301.3 Design Temperature	This paragraph does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note: this is to ensure there is no effect from thermal linear change).
301.3.1 Design Minimum Temperature	Minimum design temperature is a function of the material and the lower allowable temperatures in Table A.
301.4 Ambient Effects	Does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change).
301.5 Dynamic Effects	Impact, wind, earthquake, vibration, discharge reactions are required to be evaluated and discounted or applied.
301.6 Weight Effects	Live and dead loads are required to be evaluated and discounted or applied.
301.7 Thermal Expansion and Contraction Effects	Paragraph normally does not apply to pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change) This paragraph applies to pressure systems with appreciable thermal expansion or phase change induced volumetric expansion (increases of specific volume).
301.8 Effects of Support, Anchor, and Terminal Movements	This paragraph does not apply to pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change) This paragraph applies to pressure systems with appreciable thermal expansion or phase change induced volumetric expansion (increases of specific volume). Note: This paragraph does not apply for flex hoses restraints to reduce whip hazard
301.9 Reduced Ductility Effects	Paragraph is required to be evaluated and discounted or applied
302.2.1 Listed Components	Use listed component if available, but if none are available manufacturer's

Having Established Ratings	ratings are acceptable for the service conditions temperature, pressure, compatibility, etc…
302.2.2 Listed Components Not Having Specific Ratings	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain by Engineering Services. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
302.2.3 Unlisted Components	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain on the Engineering Services.
302.3 Allowable Stresses and Other Stress Limits	Per design may consider other protective measures in order of precedence as follows: engineering controls (barriers, interlocks or controls), procedural controls (access control), and/or PPE.
302.3.3 Casting Quality Factor, Ec	Use B31.3 paragraph as written if applicable
302.3.4 Weld Joint Quality Factor, Ej	Use B31.3 paragraph as written if applicable
302.3.5 Limits of Calculated Stresses Due to Sustained Loads and Displacement Strains	Paragraph is required to be evaluated and discounted or applied If unlisted, use manufacturer's allowable stress ratings for the material. Note: If piping and piping elements (unions, couplings, etc...) are rated above the maximum design pressure for the Normal Service and is sufficiently supported (see paragraph 321 "Piping Supports"), and the other piping components that are in the pressure system are adequately supported this paragraph does not apply.
302.3.6 Limits of Calculated Stresses Due to Occasional Loads	Do not apply paragraph if application of ESM Chapter 17 Att GEN-4 Table GEN-4-4, *Qualitative Risk (QR) Determination*, bounding conditions shows low risk (less than 3) approved by the PSO or apply paragraph.
302.4 Allowances	Fluid will be evaluated and determined to be compatible for the service life of the system with the materials of construction and manufacturer's recommendations or allowances must be added in accordance with the paragraph.
304 PRESSURE DESIGN OF COMPONENTS 304.1 Straight Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.1. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.2 Curved and Mitered Segments of Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.2 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material).

	Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. When the wall thickness is 1.5 times the minimum required by equation 3a no additional evaluation of Intrados or Extrados is required. or Use approved vendor tubing or pipe bender with their required pipe/tube to their published standard.
304.3 Branch Connections	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.3 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.4 Closures	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.4 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.5 Pressure Design of Flanges and Blanks	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.5 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.6 Reducers	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.6 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.7 Pressure Design of Other Components	Initial design consistent with the design criteria of ASME B31.3 shall be a hoop stress evaluation at the minimum wall thickness at the maximum part diameter (worst case hoop stress) showing the design meets or exceed the stress. Note: Use 31.3 material allowable stress values with B31.3 equations. Substantiation of the above may be done by one of the 4 items below: 1) For a simple part that has no stress intensification factors (notches, threads, pits, cracks, etc...) the minimum calculated

	hoop stress shall be 4x the design pressure (MAWP) 2) Determine if the piping component was previously used in accordance with paragraph 304.7.2 (a) 3) Pressure test to 4x the design pressure. 4) Perform Engineering Finite Analysis (FEA) in accordance with paragraph 304.7.2 (d)
305 PIPE	Paragraph is required to be evaluated and discounted or applied
306 FITTINGS, BENDS, MITERS, LAPS, AND BRANCH CONNECTIONS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 306. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
307 VALVES AND SPECIALTY COMPONENTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 307. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
308 FLANGES, BLANKS, FLANGE FACINGS, AND GASKETS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 308. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
309 BOLTING	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 309. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
310 GENERAL	Use B31.3 paragraph as written.
311 WELDED JOINTS	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE* [Non-destructive examination].
311.2 Specific Requirement	See above
311.2.7 Seal Welds	See above

312 FLANGED JOINTS	Conflat and KF flanges are not pressure joints unless qualified in accordance with the requirement in this table.
313 EXPANDED JOINTS	Use B31.3 paragraph as written for Normal Fluid Service
314 THREADED JOINTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 314. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
315 TUBING JOINT	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 314. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. Evaluate inter-mixed fittings using paragraph 304.7 above. May consider de-rating the fitting based on the application to define or establish the MAWP.
316 CAULKED JOINTS	Not allowed for Normal Fluid Service.
317 SOLDERED AND BRAZED JOINTS	Brazed joints shall be done in accordance with ESM Chapter 13 Welding, Joining, and NDE. Soldering shall meet B31.3 requirements.
318 SPECIAL JOINTS	Use B31.3 paragraph as written for Normal Fluid Service and evaluate in accordance with 304.7.2 in this table. NOTE: Gland here does not mean Swagelok gland fitting.
319 PIPING FLEXIBILITY	Paragraph is required to be evaluated and discounted or applied Does not apply to pressure systems where thermal expansion is not an issue. When pressure systems are used at relatively constant temperature conditions (+/- 10 F), normally within buildings and labs, and ambient temperature is less than 120 degree F this paragraph is not applicable.
320 ANALYSIS OF SUSTAINED LOADS	Piping is not to be used to support equipment (not a piping component). Paragraph is required to be evaluated and discounted or applied. Piping supports may be in accordance with LANL Master Spec Section 22 0529 for all Normal Fluid Service including pressures above 150 psig. If additional support is required see 321.
321 PIPING SUPPORTS	Use B31.3 paragraph as written in 321.1.2 "simple calculations and engineering judgment"

322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written
322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written. Pressure systems with vessels, air receivers or boilers require an ASME Stamped and approved relief device protecting the vessel, air receiver, or boiler. Existing piping relief devices may be used if they are stamped and the vessel cannot be pressurized through any other path or means. Piping relief is not required to be V-stamped if no code stamped item (pressure vessel, boiler, or air receiver) is present.

Title: **Materials**	
323 GENERAL REQUIREMENTS	Use listed materials for example: 304, 316, B88, and A108; additional listed materials are in B31.3 Appendix A. This evaluation does not apply to Test Articles.
323.1.1 Listed Materials	Use B31.3 paragraph as written.
323.1.2 Unlisted Materials	Prior to using an unlisted material the chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control must be known as required by 323.1.2. Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer’s published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the application and must be evaluated in accordance with 323.1.2 if necessary to determine the suitability of the material.
323.1.3 Unknown Materials	Don’t use unknown materials.
323.1.4 Reclaimed Materials	Use B31.3 paragraph as written.
323.2 Temperature Limitations	Use B31.3 paragraph as written.
323.2.1 Upper Temperature Limits, Listed Materials	Know the temperature limits of the materials.
323.2.2 Lower Temperature Limits, Listed Materials	Use B31.3 paragraph as written.
323.2.3 Temperature Limits, Unlisted Materials	Verify the temperature limits of the unlisted material meet the requirements of the design temperature.

	Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the temperature and must be evaluated in accordance with 323.2.3 if necessary to determine the suitability of the material.
323.2.4 Verification of Serviceability	Use B31.3 paragraph as written.
323.3 Impact Testing Methods and Acceptance Criteria (entire)	Use B31.3 paragraph as written.
323.4 Fluid Service Requirements for Materials (entire)	Use B31.3 paragraph as written.
323.5 Deterioration of Materials in Service	Designer is required to design the pressure system for the service life of the system and consider material compatibility.
325 MATERIALS — MISCELLANEOUS	Use B31.3 paragraph as written.

Title: Standards for Piping Components	
326 DIMENSIONS AND RATINGS OF COMPONENTS	Use components as defined in the code or use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain on the Engineer Services website. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
326.1 Dimensional Requirements	Apply B31.3 paragraph as written. (see 301.2.2)
326.2 Ratings of Components	Apply B31.3 paragraph as written (see 301.2.2)
326.3 Reference Documents	Apply B31.3 paragraph as written (see 301.2.2)

Title: Fabrication, Assembly, and Erection	
327 GENERAL	Use B31.3 paragraph as written.
328 WELDING (entire)	Welding and brazing shall be done in accordance with ESM Chapter 13 Welding.

330 PREHEATING	See above.
331 HEAT TREATMENT	See above.
331.2 Specific Requirements	See above.
332 BENDING AND FORMING	Bend or form in accordance with the manufactures' specification or requirements
333 BRAZING AND SOLDERING	Welding and brazing shall be done in accordance with ESM Chapter 13. Note: 317.1 Soldered Joints: "Soldered joints shall be made in accordance with the provisions of paragraph 333 and may be used only in Category D fluid service." -- i.e. soldered joints are not allowed for Normal Fluid Service.
335 ASSEMBLY AND ERECTION	Assemble in accordance with the manufacturer's requirements

Title: Inspection, Examination, and Testing	
340 INSPECTION 340.1 General	PSO Duty Area B will be the Owner's Inspector. Owner's Inspector will be knowledgeable with the pressure system of interest.
340.2 Responsibility for Inspection	Use B31.3 paragraph as written.
340.3 Rights of the Owner's Inspector	Use B31.3 paragraph as written.
340.4 Qualifications of the Owner's Inspector	See paragraph 300. PSO Duty Area B will act as the Owner's Inspector or equivalent.
341 EXAMINATION	Use B31.3 paragraph as written.
342 EXAMINATION PERSONNEL	Use B31.3 paragraph as written.
343 EXAMINATION PROCEDURES	Use B31.3 paragraph as written.
344 TYPES OF EXAMINATION	Use B31.3 paragraph as written.
345 TESTING	The Owner accepts pneumatic or hydro-pneumatic leak testing with inert gas or air (additional testing may be required by the Designer). See Exist – Legacy System Requirements (*3.B.1*) for vacuum rate of rise and inert gas referee test gas Pneumatic leak testing is approved for all systems less than 2 cubic feet in

	volume. Additional volume must be approved by the CPSO. [1] See A345 for other requirements for example test pressures (A345.4.2), test limitations (A345.2.1), and other requirements for pneumatic testing (A345.5.2) Note: Be aware of the ramifications of using high molecular weight gases to test system for lower molecular weight gas. The engineering best practice is to use a lower or equal weight molecular weight gas as the referee test gas except for hydrogen where helium is accepted.
346 RECORDS	Required information is as follows: • Sketch, • Component list (manufacturer, model number, pressure rating, FM 07 information) • Calculation • Relief device/flow calc. • Examinations • Inspections Electronic copy loaded into a master site repository.

[1] EMRef-73 ASME Interpretation of Para. 345.5.5 Pneumatic Leak Test Procedure.

Attachment NASME-1-D: Equivalency Evaluation of Category D Requirements for Metallic Piping not Associated with Pressure Vessel, Boilers, or Air Receivers (B31.3-2010, 2012, and 2014)

RECORD OF REVISION

Rev	Date	Description	POC	RM
0	9/17/14	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	6/30/15	A342 changed to use B31.3 paragraph as written. A345 added requirement based on ASME interpretation. Updates for B31.3-2014.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This evaluation of risk is per Chapter 17, Section EXIST-1 (Qualitative Risk greater than 3).

1. Applicable for B31.3 piping not including a pressure vessel, boiler, air receiver, or supporting piping.
2. Applicable only for metallic piping systems.
3. This evaluation is for new pressure systems that allow workers to be in close proximity without additional shielding while the system is pressurized.
4. For severely cyclic system see specific code requirements.
5. A list of reputable manufacturers will be maintained by Engineering Services.
6. The “Equivalent Risk Evaluation” in the table below or the original paragraph in B31.3 may be followed. The equivalency is intended to provide an equivalent level of personnel safety to B31.3, not code compliance.
7. Applies to ML-4 only.

Paragraph	Category D Fluid Service Equivalency Evaluation (within the allowance of notes above this table)
Title: Scope and Definitions	
300 GENERAL STATEMENTS (b) Responsibilities	System Owner designs system, but must be approved by PSO B for safety check. Training will be developed for System Owners to perform pressure system designs. In the interim until the training is developed and implemented, system owners with PSO assistance and concurrence may serve as designers. PSO Duty Area B may perform the role as Owner's Inspector.
300.1.3 Exclusions	Pressure systems will be inventoried with a system identification tag as defined in ESM Chapter 17. Those pressure systems that are excluded from B31.3 scope shall be declared exempt as defined in Section GEN Att GEN-2 as follows: B31.3 excludes pressure systems if less than 15 psig, nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) B31 series does not apply. LANL pressure systems where the supply pressure is greater than 15 psig but have a relief device proven adequate to protect the system from over pressurization by calculation or flow testing to less than 15 psig, and is nonflammable, nontoxic, and not damaging to human tissues with a design temperature from −29°C (−20°F) through 186°C (366°F) are excluded. In order to maintain the LANL pressure system inventory a system identification tag shall be applied in accordance with ESM Chapter 17, Section 8.0, *System Identification Tag*, with the word Exempt on the tag. The regulator and relief device must be close coupled with no intervening stop valves and identified in accordance with ESM Chapter 17 requirements. A copy of a simplified system sketch and the documentation showing the system is adequately protected against overpressure shall be maintained as records, and must be managed per LANL P 1020, P 1020-1, and P 1020-2. Relief device retest frequency is a 5 year interval.
300.2 Definitions	This table is **not** applicable to for Category M Fluid Service, Elevated Temperature Fluid Service, High Pressure Fluid Service, or High Purity Fluid Service (reference ESM Chapter 17 Section ASME Att ASME-4, contact the CPSO for other fluids not listed) Flammability limits are per Compressed Gas Association (CGA) P-23 (NFPA 55) Determination of flammability limit is per American Society for Testing and Materials (ASTM) E681-85, *Standard Test Method for Concentration Limits of Flammability of Chemicals*,

Title: Design	
301.1 Qualifications of the Designer	See above 300 General Statements (b) Responsibilities
301.2.2 Required Pressure Containment or Relief	As written for Category D Fluid Service., but using manufacturers' published rating for design pressure. Or protect personnel using other controls; engineering, administrative, and/or PPE

	as approved by the PSO as per ASME B&PVC Section VIII Div. 1 UG-140 "OVERPRESSURE PROTECTION BY SYSTEM DESIGN"
301.3 Design Temperature	This paragraph does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change).
301.3.1 Design Minimum Temperature	Lowest allowable minimum design temperature is -20 F (-29 C).
301.4 Ambient Effects	Does not apply if the pressure system is in a relatively constant temperature environment (+/- 10 F) and ambient temperature is less than 120 degree F.
301.5 Dynamic Effects	Impact, wind, earthquake, vibration, discharge reactions are required to be evaluated and discounted or applied.
301.6 Weight Effects	Live and dead loads are required to be evaluated and discounted or applied.
301.7 Thermal Expansion and Contraction Effects	Normally does not apply to pressure system is in a relatively constant temperature environment (+/- 10 deg F) and the temperature is less than 120 F (50C) (note this is to ensure there is no effect from thermal linear change) Applies to pressure systems with appreciable thermal expansion or phase change induced volumetric expansion (increases of specific volume).
301.8 Effects of Support, Anchor, and Terminal Movements	Restraints do not apply for whip hazard.
301.9 Reduced Ductility Effects	Not applicable
302.2.1 Listed Components Having Established Ratings	Listed items are recommended, but manufacturer's published ratings are acceptable.
302.2.2 Listed Components Not Having Specific Ratings	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain by Engineering Services. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
302.2.3 Unlisted Components	Use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain on the Engineering Services.
302.3 Allowable Stresses and Other Stress Limits	Per design may consider other protective measures in order of precedence as follows: engineering controls (barriers, interlocks or controls), procedural controls (access control), and/or PPE.
302.3.3 Casting Quality Factor, Ec	Use B31.3 paragraph as written if applicable
302.3.4 Weld Joint Quality Factor, Ej	Use B31.3 paragraph as written if applicable
302.3.5 Limits of Calculated Stresses Due to Sustained	Paragraph is required to be evaluated and discounted or applied

Loads and Displacement Strains	If unlisted, use manufacturer's allowable stress ratings for the material. Note: If piping and piping elements (unions, couplings, etc...) are rated above the maximum design pressure of 150 psig for Category D Fluid Service and is sufficiently supported (see Paragraph 321 "Piping Supports"), and the other piping components that are in the pressure system are adequately supported this paragraph does not apply.
302.3.6 Limits of Calculated Stresses Due to Occasional Loads	Do not apply paragraph because application of ESM Chapter 17 Att GEN-4 Table GEN-4-4, Qualitative Risk (QR) Determination, bounding conditions show low risk.
302.4 Allowances	Fluid will be evaluated and determined to be compatible for the service life of the system with the materials of construction and manufacturer's recommendations.
304 PRESSURE DESIGN OF COMPONENTS 304.1 Straight Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.1. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.2 Curved and Mitered Segments of Pipe	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.2 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. When the wall thickness is 1.5 times the minimum required by equation 3a no additional evaluation of Intrados or Extrados is required. or Use approved vendor tubing or pipe bender with their required tubing to their published standard.
304.3 Branch Connections	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.3 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.4 Closures	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.4 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.5 Pressure Design of Flanges and Blanks	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.5 The material shall meet 323.1 and must have a 3:1

	factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.6 Reducers	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 304.6 The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
304.7 Pressure Design of Other Components	Initial design consistent with the design criteria of ASME B31.3 shall be a hoop stress evaluation at the minimum wall thickness at the maximum part diameter (worst case hoop stress) showing the design meets or exceed the stress. Note use B31.3 allowable stress values with B31.3 equations. Substantiation of the above may be done by one of the 4 items below: 1) For a simple part that has no stress intensification factors (notches, threads, pits, cracks, etc..) the minimum calculated hoop stress shall be 4x the design pressure (MAWP) 2) Determine if the piping component was previously used in accordance with paragraph 304.7.2 (a) 3) Pressure test to 4x the design pressure. 4) Perform Engineering Finite Analysis (FEA) in accordance with paragraph 304.7.2 (d).
305 PIPE	Paragraph is required to be evaluated and discounted or applied
306 FITTINGS, BENDS, MITERS, LAPS, AND BRANCH CONNECTIONS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 306. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
307 VALVES AND SPECIALTY COMPONENTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 307. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
308 FLANGES, BLANKS, FLANGE FACINGS, AND GASKETS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 308. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.

309 BOLTING	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 309. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
310 GENERAL	Use B31.3 paragraph as written.
311 WELDED JOINTS	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and* Non-destructive examinations (NDE).
311.2 Specific Requirements	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE*.
311.2.1 Welds for Category D Fluid Service.	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE.*
311.2.7 Seal Welds	Welding or Brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, and NDE*.
312 FLANGED JOINTS	"Conflat" and KF flanges are not pressure joints unless qualified in accordance with the requirement in this table.
313 EXPANDED JOINTS	Use B31.3 paragraph as written for Category D Fluid Service
314 THREADED JOINTS	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 314. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply.
315 TUBING JOINT	If LANL is designing or having a design for a pressure component, the design shall comply with paragraph 314. The material shall meet 323.1 and must have a 3:1 factor of safety for materials not listed Table A1 (unlisted material). Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. Evaluate inter-mixed fittings using paragraph 304.7 above. May consider de-rating the fitting based on the application to define or establish the MAWP.
316 CAULKED JOINTS	Use B31.3 paragraph as written for Category D Fluid Service.
317 SOLDERED AND BRAZED JOINTS	Brazed joints shall be done in accordance with ESM Chapter 13 Welding, Joining, and NDE. Soldering shall meet B31.3 requirements.
318 SPECIAL JOINTS	As written for Category D Fluid Service and evaluate in accordance with 304.7.2 in this table. NOTE: Gland here does not mean Swagelok gland fitting.

319 PIPING FLEXIBILITY	The design temperature is from −29°C (−20°F) through 186°C (366°F) Paragraph is required to be evaluated and discounted or applied Does not apply to pressure systems where thermal expansion is not an issue. When pressure systems are used at relatively constant temperature conditions (+/- 10 F), normally within buildings and labs, and ambient temperature is less than 120 degree F this paragraph is not applicable.
320 ANALYSIS OF SUSTAINED LOADS	Piping is not to be used to support equipment (not a piping component). Paragraph is required to be evaluated and discounted or applied. Piping supports may be in accordance with LANL Master Spec 22 0529 for all Category D Fluid Service pressures. If additional support is required see 321.
321 PIPING SUPPORTS	Use B31.3 paragraph as written in 321.1.2 “simple calculations and engineering judgment”
322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written.
322 SPECIFIC PIPING SYSTEMS	Use B31.3 paragraph as written Pressure systems with vessels, air receivers or boilers require an ASME Stamped and approved relief device protecting the vessel, air receiver, or boiler. Existing piping relief devices may be used if they are stamped and the vessel cannot be pressurized through any other path or means. Piping relief is not required to be V stamped if no code stamped item (pressure vessel, boiler, or air receiver) is present.

Title: Materials	
323 GENERAL REQUIREMENTS	Use listed materials for example: 304, 316, B88, and A108; additional listed materials are in B31.3 Appendix A. This evaluation does not apply to Test Articles.
323.1.1 Listed Materials	Use B31.3 paragraph as written.
323.1.2 Unlisted Materials	Prior to using an unlisted material the chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control must be known as required by 323.1.2. Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer’s published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the application and must be evaluated in accordance with 323.1.2 if necessary to determine the suitability of the material.

323.1.3 Unknown Materials	Don't use unknown materials.
323.1.4 Reclaimed Materials	Use B31.3 paragraph as written.
323.2 Temperature Limitations	Any carbon steel material may be used to a minimum temperature of −29°C (−20°F) for Category D Fluid Service.
323.2.1 Upper Temperature Limits, Listed Materials	Know the temperature limits of the materials.
323.2.2 Lower Temperature Limits, Listed Materials	Select materials that are ductile (including welds/braze/solder) at -20 F. Normally these materials include 304, 316 (austenitic SS), brass, etc…; additional listed materials are in B31.3 Appendix A.
323.2.3 Temperature Limits, Unlisted Materials	Verify the temperature limits of the unlisted material meet the requirements of the design temperature. Note: This paragraph is for designing pipe and components, not for procurement of items offered for sale. If using reputable manufacturer's published ratings this paragraph does not apply. The Designer is cautioned that materials must be suitable for the temperature and must be evaluated in accordance with 323.2.3 if necessary to determine the suitability of the material.
323.2.4 Verification of Serviceability	Use B31.3 paragraph as written.
323.3 Impact Testing Methods and Acceptance Criteria (entire)	Not required for Category D Fluid Service
323.4 Fluid Service Requirements for Materials (entire)	Not required for Category D Fluid Service
323.5 Deterioration of Materials in Service	Designer is required to design the pressure system for the service life of the system and consider material compatibility.
325 MATERIALS — MISCELLANEOUS 325.1 Joining and Auxiliary Materials	Use B31.3 paragraph as written.

Title: Standards for Piping Components	
326 DIMENSIONS AND RATINGS OF COMPONENTS	Use components as defined in the code or use reputable manufacturers' published ratings. A reputable manufacturers' listing will be maintain on the Engineer Services

	website. Note: Institutional Evaluated Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.
326.1 Dimensional Requirements	Apply B31.3 paragraph as written (see 301.2.2)
326.2 Ratings of Components	Apply B31.3 paragraph as written (see 301.2.2)
326.3 Reference Documents	Apply B31.3 paragraph as written (see 301.2.2)

Title: Fabrication, Assembly, and Erection	
327 GENERAL	Use B31.3 paragraph as written.
328 WELDING (entire)	Welding or Brazing shall be done in accordance with ESM Chapter 13 Welding
330 PREHEATING	Welding or Brazing shall be done in accordance with ESM Chapter 13 Welding
331 HEAT TREATMENT	Welding or Brazing shall be done in accordance with ESM Chapter 13 Welding
331.2 Specific Requirements	Welding or Brazing shall be done in accordance with ESM Chapter 13 Welding
332 BENDING AND FORMING	Bend or form in accordance with the manufactures requirements
333 BRAZING AND SOLDERING	Welding or Brazing shall be done in accordance with ESM Chapter 13 Welding, Joining, and NDE. Soldering shall meet B31.3 requirements.
335 ASSEMBLY AND ERECTION	Assemble in accordance with the manufacturer's requirements

Title: Inspection, Examination, and Testing	
A340 INSPECTION 340.1 General	PSO Duty Area B will be the Owner's Inspector Owner's Inspector will be knowledgeable with the pressure system of interest.
340.2 Responsibility for Inspection	Use B31.3 paragraph as written.
340.3 Rights of the Owner's Inspector	Use B31.3 paragraph as written.
340.4 Qualifications of the Owner's Inspector	See paragraph 300; PSO Duty Area B will act as the Owner's Inspector or equivalent.

341 EXAMINATION 341.1 General	Use B31.3 paragraph as written.
342 Examination Personnel	Examiners shall have training and experience commensurate with the needs of the specified examinations. In the interim perform examination as defined in VAR-2012-008 while variance is in effect. Bubble leak testing Examiners will take a bubble leak test qualification course ”Category D Requirements for Piping not associated with PV, Boilers, or Air Receivers”, pass a quiz for material comprehension (80%), and be approved by a PSO B. The quiz will be retained on UTrain. The examiner will then work performing leak testing (bubble leak and hydrostatic leak test). The PSO B will maintain a list of the approved examiners during the interim or if ASNT-TC-1A certification is not desired. If the examiner desires to be ASNT-TC-1A certified they must 1) pass a written general exam, 2) pass a written specific exam, and 3) pass a hands on practical exam 4) provide documentation of sufficient hours performing the examination. Note: Level II or higher ASNT-TC-1A must comply with ESM Chapter 13 application and documentation.
343 EXAMINATION PROCEDURES	Use B31.3 paragraph as written.
344 TYPES OF EXAMINATION	Use B31.3 paragraph as written.
345 TESTING	Owner has elected to use Initial Service Leak Test for Category D Fluid Service (additional testing may be required by the Designer). See Exist – Legacy System Requirements (*3.B.1*) for vacuum rate of rise and inert gas referee test gas Pneumatic leak testing is approved for all systems less than 2 cubic feet in volume. Additional volume must be approved by the CPSO. [1] See A345 for other requirements for example test pressures (A345.4.2), test limitations (A345.2.1), and other requirements for pneumatic testing (A345.5.2) Note: Be aware of the ramifications of using high molecular weight gases to test system for lower molecular weight gas. The engineering best practice is to use a lower or equal weight molecular weight gas as the referee test gas except for hydrogen where helium is accepted.

[1] EMRef-73 ASME Interpretation of Para. 345.5.5 Pneumatic Leak Test Procedure.

346 RECORDS	Required information is as follows: • Sketch, • Component list (manufacturer, model number, pressure rating, FM07 information) • Calculation • Relief device/flow calc. • Examinations • Inspections Electronic copy loaded into a master site repository.

Table of Contents

1.0 Definition of Legacy 1
2.0 Code of Record 1
3.0 Modification or Maintenance of an Existing System 2
4.0 Disposition Requirements for Existing (Legacy, etc.) Pressure Systems 4
Attachments 13
EXIST-1 Risk-Based Engineering Evaluation of Existing (Legacy, etc.) Pressure Systems 13

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Some material had been Section I Rev 3 Article 10 and was updated.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	4/15/2015	Added boilers to risk eval table EXIST-0. Changed relief device grace period to 30 days in Table 2D.1 and moved vessels to new Table 2D.2, adding inspection interval paras from NBIC NB-23. New boiler table 2D.3 with NMAC requirements.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

1.0 Definition of Legacy

A. Systems that were operational as of March 10, 2009 when the ESM Chapter 17 revision 0 was released are considered legacy pressure systems. They are a special subset of existing systems.

B. Projects Underway: Projects in design or fabrication stages must follow this chapter.

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.[1]

2.0 Code of Record

A. The code of record (COR) refers to the code and year of the code that was specified in the original construction.

B. Legacy pressure systems must be evaluated to the latest revision of this document and the COR of the system's construction (COR defined in ESM Ch 1 Z10). If original codes or standards are unavailable, or with the Owner's approval newer editions may be applied.

1. Engineering calculations for flexibility, piping supports, and thrust when evaluating systems with small pipe size, indoor location, adequate supports, low changes in fluid system temperature, and low relief discharge energies.

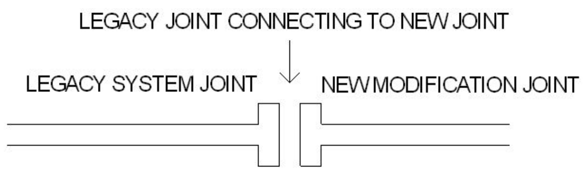
[1] Unlike most ESM chapters, this is a complete program and not only for new installations.

3.0 Modification or Maintenance of an Existing System

A. New construction addition to an existing system may be either in accordance with Section ASME or Section NASME of this Chapter as appropriate.

B. Testing of Modifications to Existing Systems

1. For existing (not only legacy as illustrated below) 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:



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 (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 that 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 1.a.3) above.

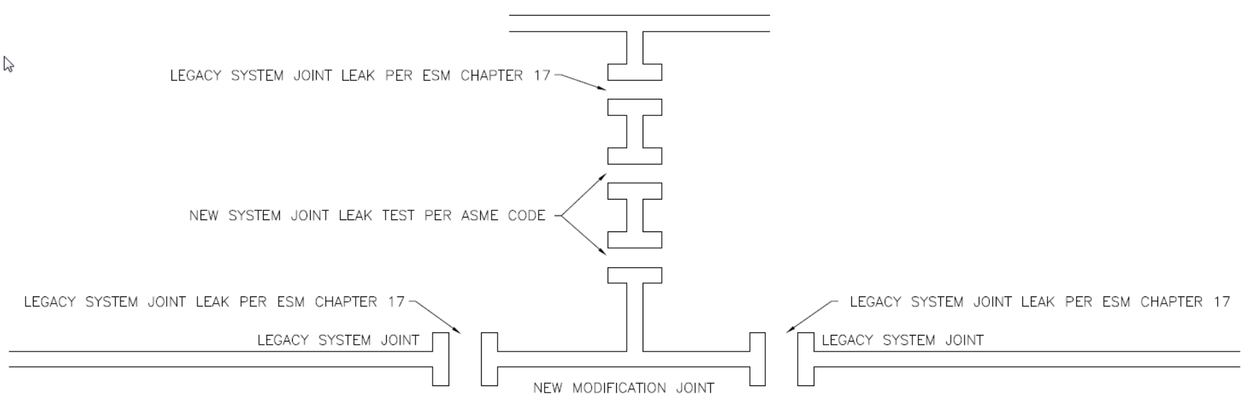
d. For leak testing pressure system modifications that only consist of ASME B31.3 or LANL CPSO-approved components with mechanical connections and/or code tested sub-assemblies, where mechanical connections are assembled in accordance with manufacturer's instruction or the applicable code or standard:

1) The initial-service leak test described by 1.a.3) above may also be performed by either or both tests as follows:

i. Vacuum rate-of-rise method: To execute a vacuum rate-of-rise leak test, the relevant sections of the system are evacuated to a predetermined absolute pressure level. The evacuation stopped and the system monitored for absolute pressure for at least five minutes. The acceptance criteria will be specified by the responsible engineer/designer and will be determined independently for each unique leak test situation based on system parameters for example volume, number of joints, and system function. Acceptance criteria will be specified as an acceptable rate of absolute pressure rise. PSO approval is required for specified acceptance criteria greater than 10^{-3} standard cc/sec.

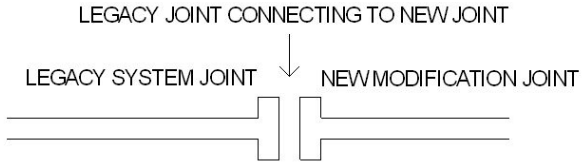
ii. Trial run of substitute referee inert gas(s) at same operating conditions as will exist with process gas(s): A trial run at the same pressure, temperature, and other salient operating conditions as process gas(s) with substitute inert gas(s) prior to introduction of the process gas(s). Pressure system will be examined for evidence of leakage at the joint(s) in accordance with the Gas and Bubble Test method specified in the B&PV Code, Section V, Article 10, or by another method demonstrated to have equal or greater sensitivity. Sensitivity of the test method shall not be less than 10^{-3} atm/ml/sec under test conditions. Allowable leakage rates higher than 10^{-3} standard cc/sec may be specified by engineering and approved by the PSO.

2. Pressure systems that that are modified as stated in “d” 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.



C. Post Maintenance Testing

1. For existing (not only legacy as illustrated below) pressure systems that require system maintenance, the affected section of piping must be tested/examined as follows:



a. For mechanical (e.g., threaded, flanged, fitting) connections see paragraph 3.0.B.1.c above.

i. For leak testing pressure system maintenance that only consists of ASME B31.3 or LANL CPSO-approved components with mechanical connections and/or code-tested subassemblies, where mechanical connections are assembled in accordance with manufacturer's instruction or the applicable code or standard, see paragraph 3.0.B.1.d.1) above.

4.0 Disposition Requirements for Existing (Legacy, etc.) Pressure Systems

A. General

1. This subsection 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 in the other Chapter 17 sections.

2. If a deficiency is identified which constitutes an imminent danger, the system shall be immediately placed in a safe configuration.

3. 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.

4. Risks are binned in three levels; examples are shown in Table EXIST-0 below.

5. The CPSO shall bin the risk if it is not listed in the Table EXIST-0.

Table EXIST-0 Deficiency Risk Levels and Bins

Risk Level 1 **High Risk**	**Risk Level 2** **Moderate Risk**	**Risk Level 3** **Low Risk**
RL1-A. Missing pressure relief device or undersized pressure relief device[2]	RL2-A. Vessel pressure rating indeterminate (unknown MAWP)	RL3-A-XXX. Missing weld examination documentation, if required Where XXX = either: IGB: Inside glovebox OGB: Outside glovebox

[2] 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

Risk Level 1 **High Risk**	**Risk Level 2** **Moderate Risk**	**Risk Level 3** **Low Risk**
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. Missing relief device calculation.	RL3-C. Missing piping flexibility or piping support analysis, if required
	RL2-D. Vessel, boiler, or pressure relief device maintenance overdue	
	RL2-E. Missing or inadequate piping supports or restraints	
	RL2-F. Relief device sizing or set point indeterminate	

B. Risk Actions

1. For the risk category examples in the table above, perform the following corrective actions (graded by FS category).[3] 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.

C. Risk Level 1 – High

Table EXIST-1, High Risk Deficiency Required Actions

	RL1-A. Missing pressure relief device RL1-B. Component, piping, or vessel known to have a MAWP less than the relief device set point
FS1-FS3	Implement compensatory measures and/or the system will be placed in a safe configuration as soon as practical and promptly correct deficiency Grace Periods: With regard to the requirement to resolve this level of deficiency “as soon as practical”, the FOD for facility systems or RAD for programmatic systems must 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.

readily available for review. The evaluation shall be considered a record and must be managed per LANL P1020, P1020-1, and P1020-2

[3] 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.

NOTE: The remaining tables (below) provide standard/default dispositions for Risk Level 2 and 3 (Moderate and Low) deficiencies. Alternatively, for these deficiency bins and where explicitly authorized below, a risk-based engineering evaluation may be performed to establish the required corrective action. These evaluations must be performed by a qualified design engineer and approved by a pressure safety officer qualified per Section GENERAL. See Attachment EXIST-1 for established risk-based evaluations for legacy systems.

D. Risk Level 2 – Moderate

Table EXIST-2A, Moderate Risk Deficiency RL2-A Required Actions

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

Table EXIST-2B, Moderate Risk Deficiency RL2-B Required Actions

	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	

Table EXIST-2C, Moderate Risk Deficiency RL2-C Required Actions

	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	

Table EXIST-2D.1, Moderate Risk Deficiency RL2-D Required Actions

	RL2-D Relief device maintenance overdue	
	Grace Period for Removal from Service (or Variance Approval) ()3F[4]	
	Non-corrosive Service	Corrosive Service
FS1	90 days	90 days
FS2	90 days	90 days
FS3	90 days	90 days
Risk-based engineering evaluations may be applied to extend the grace period with variance approval, but not to eliminate requirement to perform maintenance		

Table EXIST-2D.2, Moderate Risk Deficiency RL2-D Required Actions

	RL2-D Vessel maintenance overdue (not repair or alteration)	
	Grace Period for Removal from Service (or Variance Approval)[5]	
	Non-corrosive Service	Corrosive Service
FS1	Paragraph D.1 (below)	Paragraph D.2 (below)
FS2	Paragraph D.1 (below)	Paragraph D.2 (below)

[4] Ref. Section ADMIN-4 2.0 Inspection and Testing Intervals. Once any required PM has been performed on a component, that PM must be performed within the required maximum interval thereafter, and PMs outside of the grace period will require an approved variance to continue operation.

[5] Ibid

FS3	Paragraph D.1 (below)	Paragraph D.2 (below)
Risk-based engineering evaluations may be applied to extend the grace period with variance approval, but not to eliminate requirement to perform maintenance		

1. (D.1). Estimating Inspection Intervals for Pressure-Retaining Items Where Corrosion is Not a Factor.[6]

   When the corrosion rate of a pressure-retaining item is not measurable, the item need not be inspected internally provided all of the following conditions are met and complete external inspections, including thickness measurements, are made periodically on the vessel.

   a. The non-corrosive character of the content, including the effect of trace elements, has been established by at least five years' comparable service experience with the fluid being handled.

   b. No questionable condition is disclosed by external inspection.

   c. The operating temperature of the pressure-retaining item does not exceed the lower limits for the creep range of the vessel metal. *Refer to NBIC Part 2 (Table 4.4.8.1 in 2013)*

   d. The pressure-retaining item is protected against inadvertent contamination.

2. (D.2). Determining Inspection Intervals

   a. The maximum period between internal inspections or a complete in-service evaluation of pressure-retaining items shall not exceed one-half of the estimated remaining service life of the vessel or 10 years, whichever is less. *For further information, see NBIC Part 2, (4.4.7.1 and 4.4.7.2 in 2013) for estimating inspection intervals of pressure-retaining items subject to internal erosion or corrosion.*

   b. Inspection intervals can be revised beyond the maximum period stated above, provided the owner-user has submitted technical justification for revising the inspection interval, subject to review and acceptance by the Jurisdiction, where required.

   c. Data used in engineering assessment methods to develop revised inspection intervals for pressure-retaining items shall be re-evaluated every five years, when a change in operation occurs, or after discovery of new and/or altered damage mechanisms.

Table EXIST-2D.2, Moderate Risk Deficiency RL2-D Required Actions

	RL2-D Boiler maintenance overdue (not repair or alteration)
	Grace Period for Removal from Service (or Variance Approval)[7]

[6] NBIC-2013 Part 2 Sect. 4.4 is basis for D.1 and D.2
[7] See footnote for Table EXIST-2D.2

FS2	Comply with NMAC 14.9.4.25

Guidance: At time of writing[8], NMAC 14.9.4.25 INSPECTION METHODS AND FREQUENCY stated: The owner or user of such inspected equipment shall be responsible for obtaining a certificate of inspection. The method and frequency of boiler inspections shall be as follows:

a. The following equipment shall be inspected internally annually. A certificate inspection may be issued with an external inspection; however, an internal inspection must be made within six (6) months of the external inspection. When the construction does not permit an internal inspection, one external inspection annually is required:
   1. high-pressure boilers; [and]
   2. high-pressure steam generators.

b. Every twenty-four (24) months, an external and internal inspection shall be performed on the following:
   1. direct fire steam jacketed kettles;
   2. low-pressure steam boiler; [and]
   3. low-pressure hot-water heating boilers

Table EXIST-2E, Moderate Risk Deficiency RL2-E Required Actions

	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	

Table EXIST-2F, Moderate Risk Deficiency RL2-F Required Actions

	RL2-F. Relief device sizing or set point choice indeterminate
FS1-FS3	Locate required design information and perform calculation(s), or replace indeterminate components with components having known design characteristics and perform calculation(s).
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	

E. Risk Level 3 – Low

Table EXIST-3A-IGB, Low Risk Deficiency RL3-A-Inside GB Required Actions

RL3-A-IGB. Missing weld examination documentation (**within a glove box**[9]) – Refer to

[8] Revision of NMAC supersedes this snapshot

	Table EXIST-3A-WELD 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	

Table EXIST-3A-OGB, Low Risk Deficiency RL3-A-Outside GB Required Actions

	RL3-A-OGB. Missing weld examination documentation (**outside a glove box**) – Refer to Table EXIST-3A-WELD 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	

Table EXIST-3A-WELD Weld Examination Requirements for Full Penetration Welds when documentation is missing/insufficient

ASME B31.3			
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

[9] Or other inaccessible location; could also apply to non-toxic systems behind a barrier that protects personnel

ASME B31.1			
	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			
Nondestructive examination is not required for existing 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.

Table EXIST-3B Low Risk Level Deficiency RL3-B

	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	

Table EXIST-3C Low Risk Level Deficiency RL3-C Required Actions

	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	

F. Evaluations and Alternative Methods

1. Generic risk-based engineering evaluations have been prepared for the most common fluids have been prepared. See Attachment EXIST-1 *Risk-Based Engineering Evaluation of Legacy Pressure Systems*; these should be consulted for applicability prior to preparing an evaluation for a specific system. *Guidance: Available evaluations include but may not be limited to:*

   a. *Compressed air systems*

   b. *Inert gas cylinders*

   c. *Low pressure steam and condensate*

2. Alternate Method/Variance Approval

   a. Approval of an alternate method or variance can occur under the following circumstances:

      1) To permit continued operation prior to correction of deficiencies

      2) To permit a long-term operation with a condition that deviates from this document.

   b. 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*).

   c. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.[10]

   d. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10CFR851.

   e. Deactivation of a pressure system is an acceptable method of closing pressure safety deficiencies. Deactivating a pressure system renders the pressure system safe, and no longer a personnel hazard. There are two options for deactivation. First the system remains intact, and the second it is disassembled. The selection of the option resides with the System Owner. If the system is to be reactivated, any pressure safety issue must be resolved and it must be certified prior to operational use.

   f. FS1 or steam at or above 15 psig may be evaluated as follows:

      1) RL2B (FS1 or Steam): For existing systems with good operating history, reputable manufacturer's data may be used for MAWP. This data may

[10] On 8/14/09, NNSA Field Office and LANL agreed that FO would be copied on all LANL approved variances associated with FS1 systems; that FO would 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); and FO notified of any deficiencies discovered in safety class or safety significant systems. On 4/14/2015, NNSA delegated certain authorities to the Site Chief Engr (OPS: 26CF-608295) on the condition that NNSA would have variance involvement per AD-NHHO-14-217, *Proposed Revisions to the LANL Conduct of Engineering Variance and Alternate Method Process, 10/30/14 (NNSA COR-OPS-10.31.2014-601215).* See Ch. 1 Z10 and Form 2137 for latest VAR policy.

include the stated operating range, operating pressure, do-not-exceed values, or similar statements.

2) RL3-A (FS1 or Steam) inside or outside glove box: For existing systems with good operating history, welds shall be visually examined for defects in accordance with the most applicable code.

3) RL3-B: For existing systems with good operating history, an in process inspection shall be performed to verify the system is free from leakage at the highest normal operating pressure.

4) RL3-C: For existing systems with good operating history shall be visually inspected for sagging from inadequate support or damage from thermal expansion. If visual evidence found of these conditions is observed then the issue shall be evaluated and corrected in accordance with the most applicable code.

g. FS2 and FS3 systems may be evaluated as follows:

1) RL2B (FS2 or FS3): For existing systems with good operating history, reputable manufacturer’s data may be used for MAWP. This data may include the stated operating range, operating pressure, do-not-exceed values, or similar statements.

2) RL3-A (FS2 or FS3) inside or outside glove box: For existing systems with good operating history no additional weld evaluation is required.

3) RL3-B (FS2 or FS3): For existing systems with good operating history no additional pressure testing is required.

4) RL3-C (FS2 or FS3): For existing systems with good operating history no additional analysis RL3-B (FS2 or FS3): For existing systems with good operating history no additional pressure testing is required.

h. Closure of pressure safety PFITS issues must include evaluation and acceptance by a PSO (Duty Area A minimum).

Attachments

EXIST-1 Risk-Based Engineering Evaluation of Existing (Legacy, etc.) Pressure Systems

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Previously was Chapter 17, Section I, rev. 3, App E.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This Risk-Based Evaluation process is used in Chapter 17 Section EXIST and may be used in other situations (e.g., ASME, NASME) where allowed by those sections or with a variance (Form 2137).[1]

Guidance: The risk-based engineering evaluation evaluates the systems and determines if there is a risk to the worker (and equipment). A risk-based engineering evaluation is normally applied to non-hardware issues. A system that has known hardware issues will not likely benefit from this type of analysis.

A. Definitions

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.

2. **Consequence** – The potential outcome from an event. There may be more than one consequence from an event.

3. **Probability** – The relative frequency with which an event is likely to occur within the time frame under consideration.

4. **Acceptable Risk** – A Qualitative Risk (QR) number of 4 or higher as shown on Table EXIST-1-4, Qualitative Risk, below. Qualitative Risk shall be controlled to QR number of 4 or higher.

B. Baseline Criteria

1. The Risk-Based Engineering Evaluation applies only to systems that have correctly sized relief protection.

C. Engineering Evaluation

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 above; Risk Level 1 deficiencies must be corrected in accordance with the requirements stipulated above.

[1] Process is based on API RP 580-2009 Risk-Based Inspection methodology

a. 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.

b. The Qualitative Risk is then compared to the Acceptable Risk (i.e., risk number of 4 or higher).

c. If the Qualitative Risk is greater than the Acceptable Risk (i.e., a risk number lower than 4), then either the consequence or probability must be adjusted to achieve a risk number of 4 or higher.

2. An engineering evaluation of the pressure system shall be performed by personnel meeting the qualification requirements for a pressure system designer and approved by a qualified PSO (*see Section GEN)* with Risk Evaluation training.

3. The engineering evaluation shall be an analysis and examination of the pressure system to determine the system integrity.

4. The Risk-Based Engineering Evaluation analysis shall be included with the pressure system documentation.

5. The Risk-Based Engineering Evaluation shall ensure that hazards and dominant contributors to risk are controlled according to the following:

a. Eliminate accident scenarios (e.g., eliminate hazards or initiating events by design).

b. Reduce the likelihood of accident scenarios through design and operational changes (hazard control).

c. Reduce the severity of accident consequences (hazard mitigation).

d. 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).

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.

7. Controls shall be in applied the following order of precedence:

a. Engineered controls,

b. Administrative controls,

c. Personal protective equipment.

D. Qualitative Risk (QR)

1. The Risk-Based Engineering Evaluation shall, as a first step, use a Qualitative Risk based approach to evaluate adequacy of pressure system integrity.

2. The qualitative risk evaluation shall identify:

a. the system(s),

b. the hazard(s) (deficiency,

c. the probability assessment,

d. the consequence of failure evaluation, and

e. the subsequent QR number (see Table EXIST-1-3).

3. The Qualitative Risk based evaluation shall be based on probability and consequence of a single-point system failure for each deficiency observed.

Table EXIST-1-1 Probability factors to be considered

a. corrosion potential (crevice corrosion, general, galvanic, etc…)
b. materials of construction (composite, plastic, steel, brass, etc...)
c. material compatibility (lubricants, seals, and general materials)
d. oxygen systems
e. erosion potential
f. fatigue cycles (cycle life)
  1) low-cycle fatigue (where significant plastic straining occurs).
  2) high-cycle fatigue (where stresses and strains are largely confined to the elastic region)
g. size (contained energy)
h. human error
i. operating history
j. damage mechanisms
k. operation in creep range
l. stress intensification factors; for example, cracks or acute angles in pressure boundaries
m. available documentation
  1) welding
  2) code pressure test
n. documentation of ASME code fabrication
o. MAWP and design pressure as used in code calculations
p. design temperature
q. corrosion allowance determination
r. code required calculations (as applicable)
s. minimum wall thickness
t. nozzle reinforcement
u. thermal load calculations
v. seismic calculations
w. support structure
x. wind loading
y. piping flexibility analysis
z. cyclic loading calculations
aa. other static loadings (static fluid head)
bb. other dynamic loadings
cc. historical operational documentation
  1) corrosion rate (mils/year) (used to determine inspection interval)
  2) locations and dates of thickness measurements
  3) year of construction
  4) date of original installation
  5) date of first use
  6) out of service periods (used to determine inspection interval)
  7) discrepancy conditions
  8) a comprehensive chronological record of maintenance history
  9) history of repair – objective evidence required for ASME code stamped items.
  10) history of alterations – objective evidence required for ASME code-stamped items.
  11) historical inspections records of NDE
  12) applicable variances/waivers
  13) fabrication documentation
  14) leak test records
  15) maintenance sheet
  16) daily logs
  17) boiler records – water treatment, maintenance, and boiler appurtenances
  18) engineering evaluations as required by this chapter

4. Consequences of failure to be considered include the following safety and health issues:
   a. Chemical toxicity
   b. Physical hazards (e.g., projectiles)
   c. Flammability
   d. Radioactivity
   e. Asphyxiation hazards
   f. Volume
   g. Failure Mode
      1) Brittle fracture failure mode
      2) Leak before burst failure mode
   h. Inhabited areas
   i. Shielding (glove box, fume hood, test cell)
5. Other issues to consider include:
   a. Mission criticality
   b. Economic impact
   c. Schedule
   d. Environmental impact

E. Hazard Mitigation

1. Based on the results of the probability evaluation, a probability bin is selected as defined in Table EXIST-1-2, Failure Probability.

2. Based on the results of the consequence evaluation, a consequence bin is selected as defined in Table EXIST-1-3, Consequence of Failure.

3. Enter Table EXIST-1-4, Qualitative Risk Evaluation, and locate the QR number that corresponds to the intersection of the probability bin (A through E) and consequence bin (I through V).

4. If the QR number rating is less than 4 (i.e., 1, 2, or 3), then the Risk-Based Engineering Evaluation shall provide a methodology to reduce risk through correction of deficiencies or introduction of additional controls. Refer to Table EXIST-1-5, “Action Matrix for Existing (Legacy) Pressure System Deficiencies” *QR Action Matrix*, to determine the approved actions to correct the issues.

Table EXIST-1-2 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 EXIST-1-3 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 EXIST-1-4 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
Consequence			**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

5. The following risk-based engineering evaluation Table EXIST-1-5 applies only to legacy systems (built prior to March 10, 2009). All other systems are required to meet ESM Chapter 17 requirements for new in construction in ASME or NASME.

Table EXIST-1-5

Action Matrix for Existing (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 V of this Chapter	Create or update sketch or drawing in accordance with Section V of this Chapter	Create or update sketch or drawing in accordance with Section V 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
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

Item	Deficiency	QR 1	QR 2	QR 3
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			
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

6. Approved Qualitative Risk Evaluation (QRs)
   a. Attached to this document are approved, general qualitative risk evaluations that can be applied to existing systems meeting the LANL definition of legacy. At time of writing, these were:

      EXIST-1a, QR for Inert Gas Cylinders
      EXIST-1b, QR for Low Pressure Steam and Steam Condensate
      EXIST-1c, QR for Compressed Air Systems

General Qualitative Risk Evaluation for Inert Gas Cylinders Existing Systems Only

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Administrative update to ES-DO-QR-2010-002.0, 5/18/2010.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Assumptions:

Fluid Service

1. The system fluid service is not an FS1 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is not high pressure as define by ASME B31.3 2008 Chapter IX.
   1.2. The pressure system fluid service is not a Category M fluid ASME B31.3 2008.
   1.3. The pressure system fluid service is not steam.
2. The system fluid service is not flammable (hydrogen, deuterium, and tritium).
3. The system fluid service will not support combustions (oxidizer for example oxygen or fluorine).

System Operation

4. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
5. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
6. The pressure system does not operate in the creep range.
7. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
8. The pressure system is not an ASME Section I or VIII stamped item or unstamped item performing the same task (e.g. unstamped pressure vessel).

System Hardware

9. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
10. Corrosion is not a significant factor.
11. Materials of construction are compatible with the system fluid service.
12. The system is equipped with a properly sized, set, and functional pressure relief device(s).
13. Flexible elements are restrained to prevent whipping.

Failure Mode

14. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

15. The result of the failure will not result in personnel injury

Safety Class

16. Applicable to ML4 only.

Allowance: ESM Chapter 17 Section EXIST

RL2-A. Vessel pressure rating indeterminate, or non-ASME stamped vessel without design documentation (unknown MAWP)
Risk-based engineering evaluations may be applied for FS3 deficiencies

RL2-B. Piping component pressure rating indeterminate, or unlisted piping component (unknown MAWP)
Risk-based engineering evaluations may be applied for FS2 and FS3 deficiencies

RL3-A-inside. Missing weld examination documentation (within a glove box)
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 (outside a glove box)
Risk-based engineering evaluations should be applied for FS1 and FS2 system deficiencies to determine if weld examination is required

RL3-B. Missing pressure test documentation
Risk-based engineering evaluations may be applied for FS2 and FS3 system deficiencies

Applicable Systems
Nitrogen, helium, argon, and other inert gases fabricated from

A system with a relief device set equal to less than 150 shall be rated as FS3.

These systems shall be exempt from the requirements of having pressure test documentation, weld documentation (inside or outside the glovebox), may continue to use unlisted components, or components with an indeterminate pressure rating, or ASME non-stamped vessels.

This equipment will be considered grandfathered and will not be replaced with like items.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
			Frequent	Probable	Occasional	Remote	Improbable
Consequence	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

General Qualitative Risk Evaluation for Low Pressure Steam and Steam Condensate

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Administrative update to ES-DO-QR-2010-001.0, 5/18/2010.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Legacy Systems Only

Assumptions:

Fluid Service

1. Steam or steam condensate.

System Operation

2. No superheated steam.
3. System pressure less than 14.7 psia (212 deg. F saturated steam)
4. Piping systems only.
5. The pressure item is not an ASME Section I, ASME Section IV, or VIII stamped item or unstamped item performing the same task (e.g. unstamped pressure vessel).
6. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
7. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
8. The pressure system does not operate in the creep range.
9. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

10. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
11. Corrosion is not a significant factor.
12. Materials of construction are compatible with the system fluid service.

13. The system is equipped with a properly sized, set, and functional pressure relief device(s).
14. Flexible elements are restrained to prevent whipping.

Failure Mode

15. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

16. The result of the failure will not result in personnel injury

Safety Class

17. Applicable to ML4 only.

Allowance: ESM Chapter 17 Section IV

RL2-A. Vessel pressure rating indeterminate, or non-ASME stamped vessel without design documentation (unknown MAWP)
Risk-based engineering evaluations may be applied for FS3 deficiencies

RL2-B. Piping component pressure rating indeterminate, or unlisted piping component (unknown MAWP)
Risk-based engineering evaluations may be applied for FS2 and FS3 deficiencies

RL3-A-inside. Missing weld examination documentation (within a glove box)
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 (outside a glove box)
Risk-based engineering evaluations should be applied for FS1 and FS2 system deficiencies to determine if weld examination is required

RL3-B. Missing pressure test documentation
Risk-based engineering evaluations may be applied for FS2 and FS3 system deficiencies

Applicable Systems
Steam and steam condensate, for example building heating and condensate return piping.

A system with a relief device set equal to less than 150 shall be rated as FS2.

These systems shall be exempt from the requirements of having pressure test documentation, weld documentation (inside or outside the glovebox), may continue to use unlisted components, or components with an indeterminate pressure rating, or ASME non-stamped vessels.

This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.

Qualitative Risk Assessment

Probability: Remote (note: evaluation is remote for probability to cause significant consequence)

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
Consequence			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

General Qualitative Risk Evaluation for Compressed Air Systems

Existing Systems Only

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Administrative update to ES-DO-QR-2010-003.0, 5/18/2010.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Assumptions:

Fluid Service

1. The system fluid service is not an FS1 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is not high pressure as define by ASME B31.3 2008 Chapter IX.
2. The system fluid service is not interconnected to a flammable (hydrogen, deuterium, and tritium).
3. The system fluid service is not interconnected with a fluid that supports combustion (oxidizer for example oxygen or fluorine).

System Operation

4. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
5. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
6. The pressure system does not operate in the creep range.
7. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
8. The pressure system is not an ASME Section I or VIII stamped item or unstamped item performing the same task (e.g. unstamped pressure vessel).

System Hardware

9. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.

10. Corrosion is not a significant factor.
11. Materials of construction are compatible with the system fluid service.
12. The system is equipped with a properly sized, set, and functional pressure relief device(s).
13. Flexible elements are restrained to prevent whipping.

Failure Mode

14. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

15. The result of the failure will not result in personnel injury

Safety Class

16. Applicable to ML4 only.

Allowance: ESM Chapter 17 Section IV

RL2-A. Vessel pressure rating indeterminate, or non-ASME stamped vessel without design documentation (unknown MAWP)
Risk-based engineering evaluations may be applied for FS3 deficiencies

RL2-B. Piping component pressure rating indeterminate, or unlisted piping component (unknown MAWP)
Risk-based engineering evaluations may be applied for FS2 and FS3 deficiencies

RL3-A-inside. Missing weld examination documentation (within a glove box)
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 (outside a glove box)
Risk-based engineering evaluations should be applied for FS1 and FS2 system deficiencies to determine if weld examination is required

RL3-B. Missing pressure test documentation
Risk-based engineering evaluations may be applied for FS2 and FS3 system deficiencies

Applicable Systems

Compressed air systems, for example oil less or non-oil less air compressors used for shop air systems, calibration gas, actuation pressures, etc…

A system with a relief device set equal to less than 150 shall be rated as FS3.

These systems shall be exempt from the requirements of having pressure test documentation, weld documentation (inside or outside the glovebox), may continue to use unlisted components, or components with an indeterminate pressure rating, or ASME non-stamped vessels.

This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.

Qualitative Risk Assessment

Probability: Occasional

Consequence: Insignificant

QR Factor: 5

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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

LANL Review Processes

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Rev of material formerly in Section I Rev. 3 Article 9; implementation plan is new.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	Pressure Safety POC and Committee

This document is online at http://engstandards.lanl.gov

Table of Contents

A. PRID 2

B. Project Pressure Safety Implementation Plan (PSIP) (NEW) 2

C. Pressure System Certification Process 2

ATTACHMENTS 11

Attachment ADMIN-1-1, Pressure Safety Forms (FM01 - FM10) 11

Attachment ADMIN-1-2, Form Directions (FM01 - FM10) 11

Attachment ADMIN 1-3, Existing Pressure System Documentation 11

Attachment ADMIN 1-4, New Pressure System Documentation 11

Attachment ADMIN 1-5, Pressure System Owner Checklist (Guidance) 11

Attachment ADMIN-1-6, Risk-Based Certification Processing and Maintenance (Guidance) 11

A. PRID

1. If the CSPO determines that his/her early involvement in projects is necessary to ensure that they are aware of and properly execute this chapter's requirements, then CPSO shall be identified as an SME by the Permits Requirements Identification (PRID) tool at appropriate stages(s).[1]

2. *Guidance: The PRID process is a project planning tool used by project leaders to identify required permits, requirements, and facilitate SME reviews in the early planning stages of a project.*

3. *More information is located at this LANL web site.*

B. Project Pressure Safety Implementation Plan (PSIP) (NEW requirement this revision)[2]

1. Each project must assess and plan for compliance with ESM Chapter 17 Pressure Safety. The project-specific PSIP shall be submitted to the CPSO or designee for review and approval in the early stages of project design (e.g., 30% complete) and resubmitted at later review phases (e.g., 60%, 90%) if/as it matures. The PSIP shall address all areas of pressure safety compliance including the following items:

   a. Design pressure and temperature ranges to the extent known

   b. Identification of the code(s) of record

   c. Design output expectations (designer qualifications, specifications, drawings, calculations)

   d. Fabrication expectations (methods and qualification of fabrication personnel)

   e. ASME quality (procurement, inspection, examination, and testing requirements)

   f. Required records (manufacturers data reports, examiner procedures and qualifications, welder/brazing/soldering qualifications and procedures, and ADMIN-1-1 Forms 1 through 10)

C. Pressure System Certification Process

1. General

   a. The pressure system 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.

   b. Pressure System Certification is the end of a review process that provides documentation that the pressure system has demonstrated compliance to this chapter.

[1] Lessons learned, RLUOB and other projects.
[2] The PSIP's submittals purpose is allow LANL to confirmation that the design agency understands the requirements of this chapter at an early stage.

c. For a new pressure system or a new modification of existing pressure system Pressure System Certification means the following:

1) New pressure systems (and new modification of existing pressure systems) must be must be fabricated as required by this chapter:

a) Code construction

b) Approved Equivalency Construction

2) System documentation meeting ADMIN 1-4

3) Maintenance of relief devices, vessels, and flex hoses have been added to an automated maintenance tracking system

d. For an existing pressure system, Pressure System Certification means:

1) Fabrication meets the minimums established by this chapter

2) System documentation meeting Attachment ADMIN-1-3

3) Maintenance of relief devices, vessels, and flex hoses have been added to an automated maintenance tracking system

2. Review Process (see Process Flow Chart below)

a. The system owner is responsible for creating the required documentation and submitting it for review to the PSO.

b. The PSO is responsible for reviewing the information and identifying any non-compliance (code or non-code) if any.

c. The system owner is responsible for addressing the issues in three ways:

1) Correct the deficiency in accordance with ESM Chapter 17 requirements

2) Deactivate the pressure system

3) Request a Variance or Alternative Method per ESM Chapter 1 Sect. Z10.

d. A Variance or Alternative Method may be requested for two cases:

1) Temporary allowance for a deviation from the requirements for a finite duration to allow for correction of the deficiency while the system continues to operate.

2) Permanent allowance for a deviation from the requirements.

e. Prior to working any issue, the Management Level Determination of the pressure system must be made in accordance with AP-341-502, Management Level Determination. This determination is required information as part of Form 1 (FM01).

f. 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 P330-6.

g. After any non-compliances (code or non-code), if any, are resolved the PSO reviews the systems and the documentation and the CPSO or designee approves the system.

h. The PSO or designee inputs the data into the data repository for maintenance; the maintenance process is now instituted that will notify personnel when the pressure safety maintenance items are due (relief devices retest/replacement, vessel inspections, flex-hose inspection)

i. The CPSO or designee issues the Active sticker to the system owner or PSO who places it on the system identification tag.

Note: This system is now certified

3. Authorization to Operate Pending Certification for New Low Risk Systems

a. Authorization to Operate Pending Certification may be applied to low risk programmatic systems that meet all of the following criteria:

1) ASME B31.3 Fluid Category Normal or D (does not include steam, Category M, or high pressure).

2) The system pressure is not greater than 150 psig, based on the relief device set point.

3) Operation is within the temperature and pressure ratings of the manufactures.

4) Pressure cycles are less than 100,000 for all system components.

5) Corrosion is not a significant factor.

6) Mechanical assembly using listed components, ASME VIII stamped equipment, and/or CPSO approved components.

7) The system components have exhibited successful service experience under comparable conditions with similarly proportioned components of the same or like materials.

b. For Authorization to Operate Pending Certification, an Owner's Inspector or a Duty Area B qualified PSO must perform the following:

1) Inspect the low risk pressure system and be sure the system is adequate for the pressure or has appropriate sized relief protection.

2) Observe the code leak test, and fill out the appropriate Owner's Inspector check list.

3) Verify any necessary examination is performed.

4) Call the CPSO for a pressure system identification tag for the system.

c. The CPSO office will:

1) Issue the non-repeating pressure system number to the PSO.

2) Log the pressure system into the database.

3) Approve a 6-month operational period for the pressure system.

4) Attach an Active sticker to the system indicating the "Due Date" of the pressure system certification.

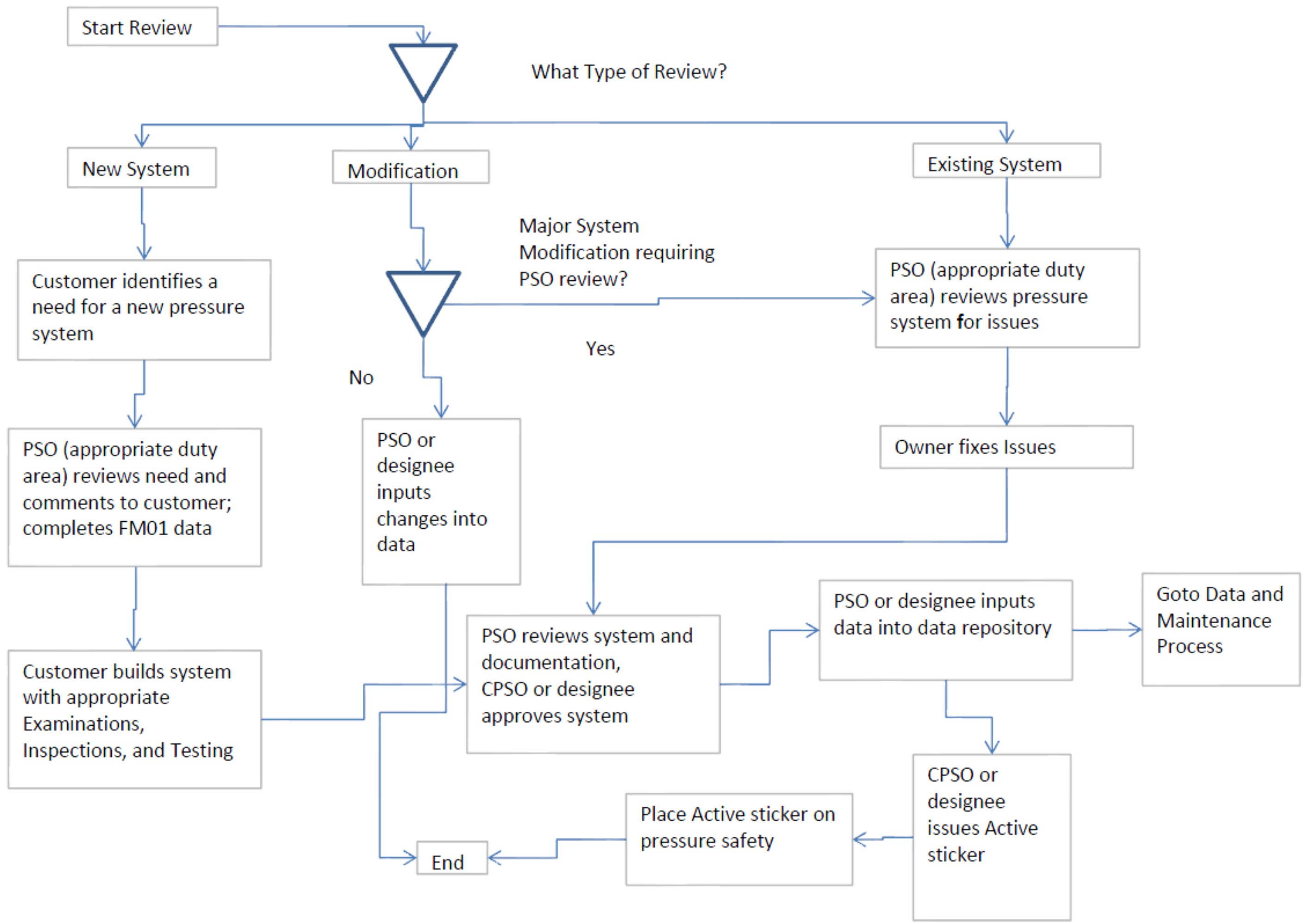
d. After six months the system is required to be certified using the normal process or the pressure system must be disconnected and disassembled.

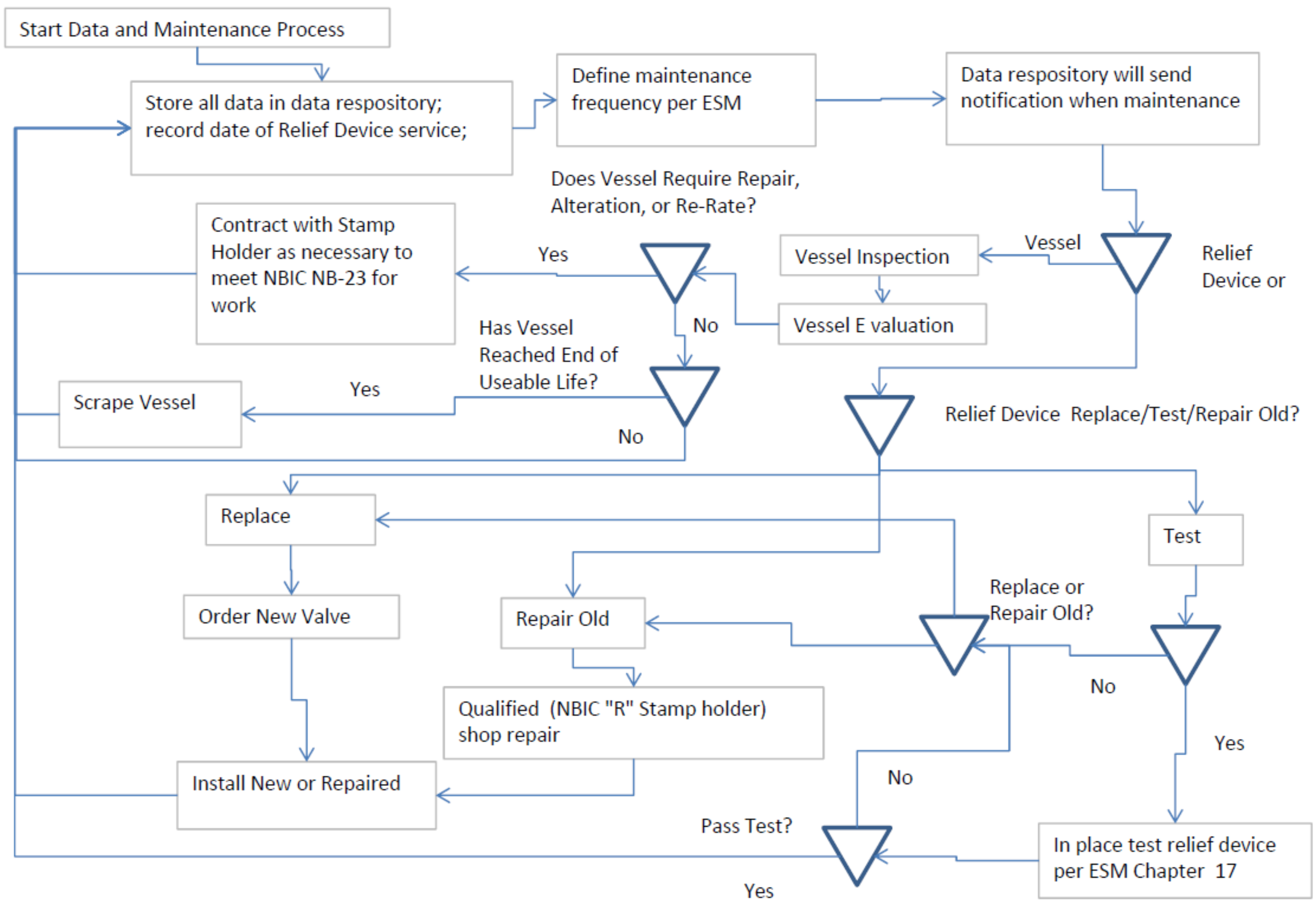
4. Other Issue Resolution

a. Inactive, deactivated, or other non-active pressure systems may be operated in order to achieve active status (e.g., perform leak checks) after the PSO has reviewed the system design, configuration, and documentation package to verify there are not safety issues.

b. Any system found to be unsafe in the opinion of the System Owner, PSO, or CPSO must be reported to the system owner and the appropriate FOD and/or RAD. Appropriate action must be taken to insure the safety of personnel.

5. Certification Process Flow Chart




Start Data and Maintenance Process
Store all data in data respository; record date of Relief Device service;
Define maintenance frequency per ESM
Data respository will send notification when maintenance
Does Vessel Require Repair, Alteration, or Re-Rate?
Contract with Stamp Holder as necessary to meet NBIC NB-23 for work
Yes
Vessel Inspection
Vessel
Relief Device or
No
Vessel E valuation
Has Vessel Reached End of Useable Life?
Scrape Vessel
Yes
No
Relief Device Replace/Test/Repair Old?
Replace
Test
Order New Valve
Repair Old
Replace or Repair Old?
No
Qualified (NBIC "R" Stamp holder) shop repair
Yes
Install New or Repaired
No
Pass Test?
In place test relief device per ESM Chapter 17
Yes

6. Conflict of Interest

   a. 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.
   b. When the CPSO has designated certification approval the CPSO and the PSO cannot be the same person to prevent conflict of interest.

7. Documenting Non-conformances

   a. Forms FM03 and FM04 or equal must be completed for all deficiencies.
   b. Non-compliances (code or non-code) for ML-1 or ML-2 systems require a non-conformance report (NCR).
   c. A copy of the NCR (Form 2082) shall be maintained in the system documentation package.

8. Deactivating a Pressure System

   a. The responsible System Owner deactivates the particular pressure system as follows:

      1) Remove hazardous materials from the system.

      2) Reducing system pressure to ambient

      3) Physically disconnect the system from all pressure sources.

   b. The PSO reviews the system and if the deactivation is acceptable updates the certification tracking database with date of deactivation.
   c. The PSO submits note into pressure system documentation package that system is not active, and maintains package in IRM document control repository.
   d. 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.
   e. PSO informs the CPSO that the pressure has been deactivated, and inactivates the related components in CMMS.
   f. CPSO or delegate updates certification tracking database showing the system as inactive.
   g. If system is to be disassembled perform the following:

      1) Notify IRM that documentation may be archived.

      2) The database tracking system entries must be archived.

      3) The identification tag must be returned to the CPSO.

9. Pressure System Identification Tag

   a. Pressure systems must be marked with a system identification tag (see below), which will be supplied by the CPSO.
   b. The purpose of this tag is to provide a means of identification and inventory 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.

c. 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.

10. Status Stickers

a. 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 Pressure Safety Certification System (PSCS) database.

b. "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.

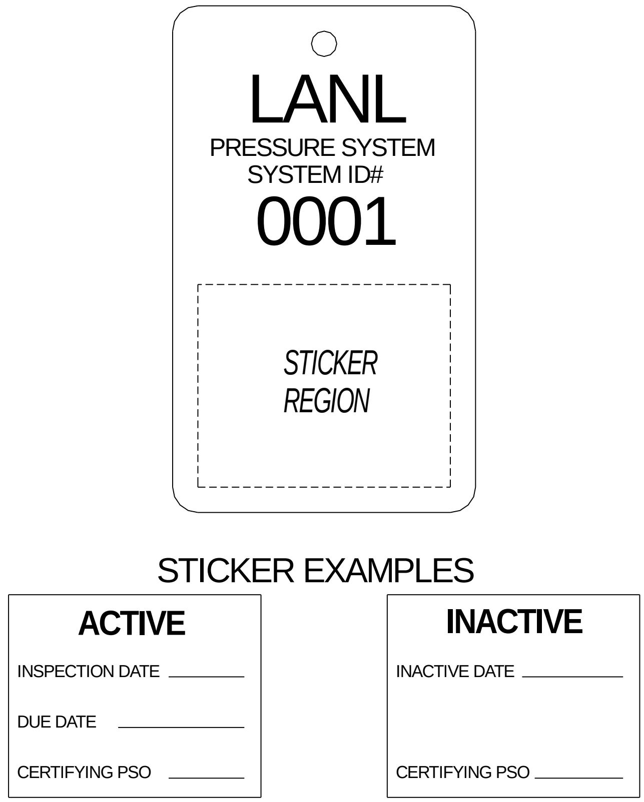
c. "Active" stickers must be issued for those pressure systems that have been certified and approved to operate as per the requirements of this document. *Guidance: "Stickers" should be covered with UV-resistant tape such as Kapton® or other similar transparent, UV-resistant tape, after being applied to the identification tag*.

d. 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.

e. LANL does not issue "Excluded" stickers instead the word "Excluded" is written on the inventory tag, and the data repository is marked as "Excluded".

f. LANL does not issue "Exempt" stickers instead the word "Exempt" is written on the inventory tag, and the data repository is marked as "Exempt".

SYSTEM IDENTIFICATION
AND CERTIFICATION TAG



11. System Relocation/Disassembly Notification Process

    a. If a pressure system is to be relocated on laboratory property, have the PCSC updated with the new location.
    b. If a pressure system is to be relocated off LANL property, updated the PSCS to indicate the system has been removed from LANL
    c. When a system is to be disassembled and removed from service, have the PSCS updated to indicate that the system has been removed from service.

ATTACHMENTS

Attachment ADMIN-1-1, Pressure Safety Forms (FM01 - FM10)

Attachment ADMIN-1-2, Form Directions (FM01 - FM10)

Attachment ADMIN 1-3, Existing Pressure System Documentation

Attachment ADMIN 1-4, New Pressure System Documentation

Attachment ADMIN 1-5, Pressure System Owner Checklist (Guidance)

Attachment ADMIN-1-6, Risk-Based Certification Processing and Maintenance (Guidance)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Supersedes forms associated with Section I Rev 3.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	4/15/2015	Removed signatures from forms and incorrect citations from FM10	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Pressure Safety Forms FM01 - FM10

1. The appended forms are samples, provided to illustrate the minimum information required[1].
2. The information shall be managed as a record and must comply with LANL P1020-1 *Laboratory Records Management*, and P1020-2, *Laboratory Document Control*. Normally this information will be placed in the PSCS database and then EDMS.
3. Any spreadsheet-based or individual Word forms posted online with this chapter may be used in lieu of these samples.

FM01	Pressure System Certification Status Form
FM02	PRV Recall Summary Sheet
FM03	Code Non-Compliance Log
FM04	Minor Non-Compliance Log
FM05	Flexible Pressure Element Visual External Examination
FM06	Tubing and Piping Data Sheet
FM07	Pressure System Component List
FM08	Relief Device Placement Verification Record

[1] As such may be revised for format or to reduce required information with POC and Standards Manager approval as an admin change.

FM09	Thrust Consideration Data Sheet
FM10	System Schematic

Additional direction on how the forms are used, and what is specifically required to document a pressure system, is provided in the following attachments to ADMIN-1:

ADMIN-1-2	Form Directions
ADMIN-1-3	Existing (Legacy) Pressure System Documentation Requirements
ADMIN-1-4	New Pressure System Documentation Requirements

FM01

Pressure System Certification Status Form

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

System ID No.:	Excluded System: Yes ☐ No ☐
Other System Identification Name (or Number):	
System Location (TA-BLDG-Room): - - (Not applicable if mobile)	
Mobile System "T" Number: (Not applicable if mobile)	
System Contents (N_2, AR, etc.): (Do not list if Classified)	
System Fluid Category (FS1, FS2, FS3):	
System Design Pressure:	
System Design Temperature Minimum	
System Design Temperature Maximum	
PRD Set Pressure(s)	
Applicable ASME B&PVC Section for System:	Applicable B31 Code for system:
System Owner:	Phone/Pager:
Last Re-certification (MM/DD/YY):	
Next Re-certification (MM/DD/YY):	
Reviewer Name:	

Notes:

Approval Signature List:	**Printed Name & Z #**	**Signature**	**Date**
FOD PSO Certification			
CPSO Certification			

FM02

PRV Recall Summary Sheet

System Name and ID No.:

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 Number

FM03

Code Non-Compliance Log*

System ID No.:	
System Description	
Page _____ of _____	

Description	Code Requirements (Section, Chapter & Paragraph)	Closure & Rationale	Closure date & LANL PSO Signature & Z #

* Examples are: Undersized relief device, wrong set pressure on relief device, weld repairs without “R” stamp, component MAWP less than design system pressure, un-supported 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[2,3]

System ID No.:					
System Description					
Page _____ of _____					
Description	**Requirement (LANL Document, Section & Paragraph)**	**Closure & Rationale**	**Closure date & Initials**		
			Owner	**FOD PSO**	

[2] 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.

[3] For ML-1 or ML-2 initiate an NCR

FM05

Flexible Pressure Element Visual External Examination

System ID No.:		
Date of Inspection	FOD PSO Signature & Z #	

Component Number	**MAWP**	**Integrity**		**Are Flex Hose Restraints used Yes or No**	**Flex Hose Restraint**	
		ACCEPTABLE (good condition, no visible flaws)	**UNACCEPTABLE (Describe)** (kinks, frayed, crushed, etc.)		**ACC**	**UNACC**
					☐	☐
					☐	☐
					☐	☐
					☐	☐
					☐	☐
					☐	☐

FM06

Tubing and Piping Data Sheet[1]

System ID No.:	Drawing #		Date	

Components that tubing/Piping section is located between. **(eg. MV-4 & PI-3)** *This is N/A if all piping/tubing is the same size and type throughout entire system*	**Tubing Material** **(SS, CU, CS, etc.)**	**Tubing Spec./Grade** **(316-A26, 304L-A358, etc.)**	**OD (in.)**	**ID (in.)**	**Seamless**		**Max Operating Temp °F**
					☐ Yes	☐ No	
					☐ Yes	☐ No	
					☐ Yes	☐ No	
					☐ Yes	☐ No	
					☐ Yes	☐ No	
					☐ Yes	☐ No	
					☐ Yes	☐ No	

[1] This data sheet accomplishes the requirements found in ASME B31.3, Paragraph 323.1.3

FM07

Pressure System Component List *

Pressure system documentation package I.D. Number:

System Location (TA-BLDG- - - Room):

Component I.D.	Manufacturer	Model Number	Material (316S.S., Brass, etc.)	MAWP	Soft Goods Material(s)[1]	Code Stamp (U, UV,etc.)[2]	Listed Item (Y/N)	Code of Item

[*] 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 visa-versa.

FM08

Relief Device Placement Verification Record[1]

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 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)

[1] This data sheet accomplishes the requirements of ASME B31.3, Paras. 301.2.1 & 301.2.2

FM09

Thrust Consideration Data Sheet [1]

Use 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 or sustained thrust (lbf)	Type of restraint Mechanism (if any installed)	Maximum loading restraint can withstand [2] (lbs)

[1] This data sheet accomplishes the requirements of ASME B31.3, Paragraph 301.5.5, 322.6.2 & Appendix G
[2] As determined by manufacturers' documentation, finite element analysis, calculations, catalog description, etc.

FM10

System Schematic (Sample)

Sketch the pressure system

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

Minimum Acceptable Documentation Necessary to Meet the Requirements of ESM Chapter 17

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Use the tables in this document as a checklist. Some items listed may not be required if there is not an item that fits the description in the pressure system. Some examples are:

> If the pressure system does not contain a vessel (as defined in ASME Boiler and Pressure Vessel Code Section VIII, Div 1, paragraph U-1(c)(2)), then Table ADMIN-1-1 items #4 “Code Stamped Vessel Fabrication Documentation” and item #5 “Non-ASME code Fabricated Vessel Information (code-equivalent Documentation)” are not required.
>
> If a system is located inside a temperature controlled environment and will not experience relatively large thermal cycles then a calculation evaluating thermal growth is not required.

As stated in elsewhere in this chapter, “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”

How to determine which forms are required is as follows:

Form Number	Description of Form	Notes
FM01	This form (or equivalent) is required for all packages. This form has been modified to state "Signature of the PSO indicates that all deficiencies have been resolved, including deficiencies tracked in PFITS", and "Signature of the PSO indicates that the Maximum Allowable Working Pressures (MAWPs) of the system components have been reviewed and that the set point of the pressure relief valve is equal to lower than, the lowest component MAWP".	
FM02	This form (or equivalent) is required for all packages. This form is required to be loaded into the Pressure Safety Certification System database with the minimum information required for CMMS entry (see the Attachment 2: Minimum Required Data Entry into CMMS).	As an alternative to directly loading this information into the database, a direct entry into the CMMS maybe performed and documentation of the update submitted with the pressure system package for certification.
FM03	In accordance with the note on FM01, all FM03 entries will have been closed prior to submission for certification.	The PSO or CPSO may elect to use FM03 or DRR forms to comment on the pressure safety package submission.
FM04	In accordance with the note on FM01, all FM04 entries will have been closed prior to submission for certification.	The PSO or CPSO may elect to use FM04 or DRR forms to comment on the pressure safety package submission.
FM05	If flexible elements (not non-metallic pipe/tube) are system components, an inspection of the hoses will be performed to ensure they are still adequate for the application.	Evaluation of hoses may be performed to manufacturer guidelines or Designer specified requirements.
FM06	Specifies actual pipe or tube material, thickness, and size used in the construction.	This form is not required if the information is included as part of the system schematic sketch, an Excel spreadsheet, or Master Equipment List
FM07	A listing of system components is required.	This form is not required if the information is included as part of the system schematic sketch, an Excel spreadsheet, or Master Equipment List
FM08	If the system is designed for the system pressure or protected by a relief device this form is not required.	

Form Number	Description of Form	Notes
FM09	A reference to a bounding calculation (see Notes) is sufficient to show that thrust considerations have been considered.	Bounding calculations could be, for example: System 4980 PSV set at 225 psig reaction loads showed 52 lbf; System 4375 PSV set at 200 psig showed 80 lbf on a ¼ inch elbow. All forces were absorbed by the tubing systems and normal tubing supports.
FM10	System schematic sketch	
FM11	Not required	This was used by the walkdown team to document the configuration of the relief protection.

Additional Information Required for Pressure System Packages

Relief Protection

A formal pressure relief device calculation is required for all systems. This calculation may be a comparison using the LANL approved calculations, CALC-10-00-786-PSS-GEN-00001 Rev.0 and CALC-10-00-786-PSS-GEN-00001 Rev.0, (or successors) assuming the conditions of the calculations are met.

Component MAWP or Rating

Supporting documentation must be presented that contains manufacturer's rating of items that are not ASME B31.3 piping components.

> ASME B31.3-2010 paragraph 300.2 **Definitions**:
> *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.

Examiners and Examinations

An Examiner with the necessary training and experience must be appointed by the Responsible Line Manager in accordance with LANL Policy P330-8, paragraph 3.6.

3.6 Inspection and Test (I/T) Personnel Qualification/Certification

The RLM will appoint appropriate personnel and identify the qualification requirements for qualifications/certifications not identified in this section.
Qualification records of I/T workers must be maintained as a record in accordance with P1020-1, *Laboratory Records Management*.

3.6.7 Test Personnel

Test personnel must have the knowledge, skills, and abilities to adequately and safely perform the required test process. In some cases, specific qualification and certification requirements will apply.

These requirements must be specific in the test plan or procedures. Organization-specific qualification and certification procedures may be necessary (e.g., boiler and pressure vessel test, leak testing).
Note: For guidance on content and approval of test personnel qualification and certification contact the QA Division at 665-5437 or Engineering Services Division at 606-0600.

The following is required by ASME Code B31.3-2010:

342.1 Personnel Qualification and Certification

Examiners shall have training and experience commensurate with the needs of the specified examinations. The employer shall certify records of the examiners employed, showing dates and results of personnel qualifications, and shall maintain them and make them available to the Inspector.

346.3 Retention of Records

Unless otherwise specified by the engineering design, the following records shall be retained for at least 5 years after the record is generated for the project:

(a) Examination procedures

(b) Examination personnel qualifications

Examiner certificates must be supplied indicating that the necessary examinations were performed and acceptable. This is required by the ASME Code B31.3-2010:

341.4.1 Examination — Normal Fluid Service.

(c) Certifications and Records. The examiner shall be assured, by examination of certifications, records, and other evidence, that the materials and components are of the specified grades and that they have received required heat treatment, examination, and testing. The examiner shall provide the Inspector with a certification that all the quality control requirements of the Code and of the engineering design have been carried out.

Owner's Inspector Report

A LANL Owner's Inspector, qualified and accepted by the LANL Construction Management, shall perform an evaluation of the system in accordance with their standard procedures. A LANL qualified Duty Area B PSO may serve as an Owner's Inspector for piping systems which fall under the scope of ASME B31.3.
A copy of the Owner's Inspector checklist and report is required to be included in the pressure safety package.

Leak Testing

Leak Test is a code term for a pressure test conducted on the pressure system before it is ready for operation. A Leak Test report is required to be included in the pressure safety package.

Calculations

For existing FS-2 and FS-3 systems it is appropriate to apply engineering judgment for existing pressure systems with successful service history, and not perform strict engineering evaluations when evaluating small pipe size, indoor locations, with adequate supports, and low relief energies. The evaluation must not conflict with safety basis.

Existing (including Legacy) System Documentation Requirements[1]

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Modification of Table 16.1 of Chapter 17, Section I, rev. 3.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Table ADMIN-1-3-1

Documentation Requirements for Existing (including Legacy) Systems

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)[2]	Every Package		
5. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		

[1] The requirements for existing systems reflect the graded approach described in other sections of this Chapter, and take credit for successful operating history.

[2] 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	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
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 OR in-service leak test for FS2 and FS3 as allowed in ESM Chapter 17.	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		

Attachment ADMIN-1-3 Rev. 0, 9/17/2014

Existing (including Legacy) System Documentation Requirements

Documentation Package Item	Required When	Owner Verification	PSO Verification
h. Vessel modification reports	Vessel is modified from the as purchased condition.		
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 and/or rupture discs, 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, (for example valve repair, orifice replacement, gasket replacement,	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; in accordance with ASME B&PV Code	PRDs are used as protection against liquid lock overpressure. See ASME B&PVC UG-128.		
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		

REDUCED REQUIREMENTS (LOW RISK)
System documentation requirements of Table ADMIN-1-3-1 may be reduced for legacy systems meeting the following criteria:

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. Corrosion is not a significant factor.
4. There are no stress intensification factors for examples cracks or acute angles of pressure boundaries.
5. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like materials.
6. The pressure system is not high pressure as defined by ASME B31.3 2010 Chapter IX.
7. The pressure system is fluid is not Category M fluid as defined by ASME B31.3 2010.
8. The pressure system fluid is not steam.
9. The pressure system does not operate in the creep range.
10. The pressure system is not an ASME Section I, IV, VIII, or XII stamped item or an unstamped item performing the same task (e.g. a code equivalent vessel).
11. ASME B31.3 Fluid Category Normal or D.

When the above criteria are met, the system must pass an initial service leak test at the normal system operational pressures. Then, Table ADMIN-1-3-1 items 7.b-f, 9.a-b, and 10 are not required and Table ADMIN-1-3-1 becomes Table ADMIN-1-3-1ALT as follows:

Table ADMIN-1-3-1ALT

Alternative Documentation Requirements for Existing (including Legacy) Systems[3]

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), or reference on Form 1 to closed PFITS issue numbers.	If Applicable		
3. Form 4, Minor Non-Compliance Log (Form can be printed from Pressure Safety Database by PSO), or reference on Form 1 to closed PFITS issue numbers	If applicable		

[3] The requirements for existing systems reflect the graded approach described in other sections of this Chapter, and take credit for successful operating history.

Existing (including Legacy) System Documentation Requirements

Documentation Package Item	Required When	Owner Verification	PSO Verification
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)[4]	Every package		
5. Alternate Method/Variance or clarification/interpretation (if applicable). Only include system-specific, rather than generic, alternate methods, variances, clarifications, or interpretations.	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
6. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. Record the NBIC tag number. 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.		
7. 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		

[4] 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
8. 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		
a. Documentation of relief valve modification, if required	If a relief valve has been modified		
b. 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.		
c. Pump or compressor discharge pressure curves, calculation, or table (if available)	The pressure system contains pumps or compressors		
d. Oxygen System Hazard Analysis (if applicable)	Pressure system is an oxygen system		

Qualitative Risk-Based Evaluation (QR)-based Documentation Requirements for Legacy Pressure Systems

Tables ADMIN-1-3-A through ADMIN-1-3-U

Summary

In addition to the ADMIN-1-3-1ALT option above, and unless required by the CPSO (or when required by the risk-based evaluation), no detailed design information is required for B31.3 legacy pressure system documentation for systems that meet certain evaluation categories. This includes code-required piping and support calculations (e.g. ambient effects, weight effects, dynamic effects, flexibility analysis, pipe supports, wind loading, and seismic loading) see specific code for additional detail (e.g. B31.3 paragraphs 301.4 to 301.11, 319, and 321). In addition, no examination or inspection reports are required. These exemptions do not apply to pressure vessel and relief device analyses.

It is the user's responsibility to ensure that systems that use these general pressure system legacy risk evaluations meet all the criteria established by the QR contained in this document.

The requirements for a general legacy pressure system with the highest hazard rank shall dominate for that specific portion of the pressure system. If other portions of the pressure system are engineered differently at a lower hazard rank, then those portions of the pressure system may be evaluated to the applicable general legacy pressure system risk-based engineering evaluation.

Table 1-3-1-SUM summarizes documentation required for certification of pressure system that meet the General Legacy Pressure System Description. The "Replacement Table ADMIN-1-3-" column defines which table will replace the Table ADMIN-1-3-1 requirements.

Existing (including Legacy) System Documentation Requirements

Information required on system schematics or forms 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 information shall be considered a record and must be managed per LANL P1020, P1020-1, and/or P1020-2.

Table 1-3-1-SUM Summary of Legacy Qualitative Risk-Based Engineering Matrix Requirements

Evaluation Category	General Legacy Pressure System Description	Fluid Service	Hazard Rank	Replacement Table ADMIN-1-3-	PSO/CPSO Certification FM01	Relief Protection Calculation and FM02	ASME Vessel or Equivalent Calculations	Pipe/Tube Wall Thickness FM06	Known Component MAWP FM07	Sketch FM10	Piping and Support Design Calculations
1	High Pressure – Pneumatic	FS1	1	A	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
2	Toxics (Category M)	FS1	2	B	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
3	Steam	FS2	3	C	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
4	High Pressure – Liquid High Volumetric Rate	FS1	4	D	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
5	Corrosive[1]	FS2, FS3	5	E	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
6	Brittle Failure Mode (not leak before burst)	FS2, FS3	6	F	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
7	Oxygen[2]	FS2, FS3	7	G	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
8	Flammables	FS2	8	H	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	No
9	Cryogenic Liquids	FS2	9	J	**YES**	**YES**	**YES**	No	**YES**	**YES**	No
10	Steam Condensate	FS3	10	K	**YES**	**YES**	**YES**	No	No	**YES**	No
11	Compressed Air	FS2, FS3	11	M	**YES**	**YES**	**YES**	No	No	**YES**	No

Existing (including Legacy) System Documentation Requirements

Evaluation Category	General Legacy Pressure System Description	Fluid Service	Hazard Rank	Replacement Table ADMIN-1-3-	PSO/CPSO Certification FM01	Relief Protection Calculation and FM02	ASME Vessel or Equivalent Calculations	Pipe/Tube Wall Thickness FM06	Known Component MAWP FM07	Sketch FM10	Piping and Support Design Calculations
	with Receiver										
12	Compressed Inert Gases – DOT Cylinders	FS2, FS3	14	N	**YES**	**YES**	**YES**	No	No	**YES**	No
13	Compressed Air Without Receiver	FS2, FS3	12	P	**YES**	**YES**	No	No	No	**YES**	No
14	Compressed Inert Gases – Building Systems	FS3	13	R	**YES**	**YES**	**YES**	No	No	**YES**	No
15	High Pressure –Low Liquid Volume	FS1	15	S	**YES**	**YES**	No	No	No	**YES**	No
16	Hydronic piping	FS3	16	T	**YES**	**YES**	No	No	No	**YES**	No
17	Water Systems	FS3	17	U	**YES**	**YES**	No	No	No	**YES**	No

[1] **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.

[2] Evaluate oxygen systems as required in ASTM G128 and other referenced ASTM standards to determine the likelihood of fire.

(***Note**: New Table Numbers “ADMIN-1-3-I”, “ADMIN-1-3-L”, “ADMIN-1-3-O”, and “ADMIN-1-3-Q” were not used to eliminate confusion)

General Legacy Pressure System Description for High Pressure – Inert Pneumatic

Evaluation Category 1

Assumptions:

Fluid Service

1. The system fluid service is a FS1 as defined by ESM Chapter 17
    1.1. The pressure system fluid service is high pressure as define by ASME B31.3 2010 Chapter IX.
2. Corrosion is not a significant factor.
3. Materials of construction are compatible with the system fluid service.

System Operation

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. The pressure system does not operate in the creep range.
4. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury.

Safety Class

1. Applicable to ML4 only.

Existing (including Legacy) System Documentation Requirements

Documentation Requirements

1. These high pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These high pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-A include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. These high pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the high pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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

Existing (including Legacy) System Documentation Requirements

Table ADMIN-1-3-A

General Legacy Pressure System Documentation for High Pressure – Inert Pneumatic

Documentation Package Item	Comment	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 6, Piping System thickness verification	Every Package		
3. Form 7, Component List	Every Package		
4. Form 10, Form 10, 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)[5]	Every Package		
5. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		

[5] Information required on Form 10, 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

Table ADMIN-1-3-A

General Legacy Pressure System Documentation for High Pressure – Inert Pneumatic

Documentation Package Item	Comment	Owner Verification	PSO Verification
6. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. Record the NBIC tag number. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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. Vessel thickness and remaining life estimate	Every Package		
8. Piping System Documentation:			

Table ADMIN-1-3-A

General Legacy Pressure System Documentation for High Pressure – Inert Pneumatic

Documentation Package Item	Comment	Owner Verification	PSO Verification
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. FM07	Every Package		
9. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
10. Pump or compressor discharge pressure curves, calculation, or table (If available)	Only applicable if the pressure system contains pumps or compressors		

General Legacy Pressure System Description for Toxics

Evaluation Category 2

Assumptions:

Fluid Service

1. The system fluid service is a FS1 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is Category M as define by ASME B31.3 2010 Chapter IX.
2. Corrosion is not a significant factor.
3. Materials of construction are compatible with the system fluid service.

System Operation

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. The pressure system does not operate in the creep range.
4. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

1. The result of the failure may result in serious personnel injury

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These toxic pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These toxic pressure systems may continue to use unlisted components provided the manufacturer's rating is adequate.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-B include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. These toxic pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the toxic pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Serious

QR Factor: 3

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
			Frequent	Probable	Occasional	Remote	Improbable
Consequence	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 ADMIN-1-3-B

General Legacy Pressure System Documentation for Toxic

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[78]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable). See Part 10.0 of this standard.	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[78] Information required on Form 10, 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

Table ADMIN-1-3-B

General Legacy Pressure System Documentation for Toxic

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
a. FM07	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Steam

Evaluation Category 3

Assumptions:

Fluid Service

1. The system fluid service is an FS2 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is steam as define by ASME B31.1 (steam greater than 15 psig or high temperature water exceeding 160 psig).
   1.2. The pressure system fluid service is steam as define by ASME B31.9 (steam less than 15 psig or less, and water heating units to 160 psig)
2. Materials of construction are of known compatible with steam and an estimate of remaining life is available.

System Operation

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. The pressure system does not operate in the creep range.
4. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.
7. The steam system is constructed from iron metallic materials suitable for elevated service.

Failure Mode

1. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

1. The result of the failure may result in serious personnel injury.

Safety Class

1. Applicable to ML4 only.

Existing (including Legacy) System Documentation Requirements

Documentation Requirements

1. Existing steam pressure systems shall be exempt from the requirements of having code leak test documentation.
2. Existing steam pressure systems may continue to use unlisted components provided the manufacturer's rating is adequate.
3. Existing steam systems equipment will be considered grandfathered and shall be upgraded to ASME requirements as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-C include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10). .
5. Piping shall be of known or verified wall thickness (FM06).
6. Existing steam pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the steam pressure system they must be evaluated for current MAWP based on the most applicable code or standard.
8. Existing steam systems must be evaluated for thermal growth if evidence exists of previous repair or damaged caused by thermal growth (rupture, bending, etc…)

Qualitative Risk Assessment

Probability: Remote

Consequence: Serious

QR Factor: 3

Table 3 Qualitative Risk (QR) Determination

			Probability				
Consequence			**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 ADMIN-1-3-C

General Legacy Pressure System Documentation for Steam

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[7]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
a. Vessel thickness and remaining life estimate	Every Package		

[7] Information required on Form 10, 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

Table ADMIN-1-3-C

General Legacy Pressure System Documentation for Steam

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
9. Piping System Documentation:			
a. Provide documentation evaluating effects of thermal growth.	If evidence of historical thermal growth problems.		
b. Form 06, Piping thickness and remaining life estimate	Every Package		
c. Form 07	Every Package		

General Legacy Pressure System Description for

High Pressure – Liquid High Volumetric Rate

Evaluation Category 4

Assumptions:

Fluid Service

1. The system fluid service is a FS1 liquid with a high flow liquid rate such that whipping of flex lines is an issue.
   1.1. The pressure system fluid service is high pressure as define by ASME B31.3 2010 Chapter IX.
2. Materials of construction are of known compatible with fluid and an estimate of remaining life is available.
3. Corrosion is not a significant factor.

System Operation

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. The pressure system does not operate in the creep range.
4. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

2. The result of the failure will not result in serious personnel injury.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. The existing high pressure – liquid high volumetric rate pressure systems shall be exempt from the requirements of having code leak test documentation.
2. The existing high pressure – liquid high volumetric rate pressure systems may continue to use unlisted components provided the manufacturer's rating is adequate.
3. The existing high pressure – liquid high volumetric rate pressure systems equipment will be considered grandfathered and shall be upgraded to ASME requirements as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-D include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. The existing high pressure – liquid high volumetric rate pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the high pressure – liquid high volumetric rate pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-D

General Legacy Pressure System Documentation for High Pressure – Liquid High Volumetric Rate

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[8]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[8] Information required on Form 10, 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

Table ADMIN-1-3-D

General Legacy Pressure System Documentation for High Pressure – Liquid High Volumetric Rate

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. FM07	Every Package		

General Legacy Pressure System Description for Corrosives

Evaluation Category 5

Assumptions:

Fluid Service

1. The system fluid service is a FS2 or FS3 as defined by ESM Chapter 17
2. The pressure system fluid service is corrosive and is defined as Fluid Category Normal by ASME B31.3 2010 Chapter IX.
3. Materials of construction are of known compatible with fluid and an estimate of remaining life is available.

System Operation

1. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs).
2. High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
3. The pressure system does not operate in the creep range.
4. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (not brittle fracture).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. The existing corrosive pressure systems shall be exempt from the requirements of having code leak test documentation.

2. The existing corrosive pressure systems may continue to use unlisted components provided the manufacturer's rating is adequate.
3. The existing corrosive pressure systems equipment will be considered grandfathered and shall be upgraded to ASME requirements as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-E include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. Existing corrosive pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the corrosive pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
Consequence			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 ADMIN-1-3-E

General Legacy Pressure System Documentation for Corrosive (characteristic of fluid and boundary materials)

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, System schematics (If the owner does not have a system schematic, utilize the sketch prepared by the walk down team until such time as system schematic is prepared)[9]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[9] Information required on Form 10, 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

Table ADMIN-1-3-E

General Legacy Pressure System Documentation for Corrosive (characteristic of fluid and boundary materials)

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. FM07	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Brittle Failure Mode

Evaluation Category 6

Assumptions:

Fluid Service

1. The system fluid service is a FS2 or FS3 as defined by ESM Chapter 17
2. Materials of construction are compatible with the system fluid service.

System Operation

1. The pressure system does not operate in the creep range.
2. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
3. The system is not subject to pressure spikes for example water or steam hammer.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A brittle failure mode is assumed.

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These brittle pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These brittle pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.

4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-F include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. These brittle pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the brittle pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-F

General Legacy Pressure System Documentation for Brittle Failure Mode (not leak before burst)

	Documentation Package Item	Comment	Owner Verification	PSO Verification
1.	Form 1, LANL Pressure System Certification Status Form	Every Package		
2.	Form 6, Piping System thickness verification	Every Package		
3.	Form 7, Component List	Every Package		
4.	Form 10, Form 10, 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)[10]	Every Package		
5.	Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
6.	Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
	a. Vessel thickness and remaining life estimate	Every Package		
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)		

[10] Information required on Form 10, 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

Table ADMIN-1-3-F

General Legacy Pressure System Documentation for Brittle Failure Mode (not leak before burst)

Documentation Package Item	Comment	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
9. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. FM07	Every Package		
c. MAWP determination of brittle component	Determination of MAWP of brittle component will all loads required by code.		
10. Pump or compressor discharge pressure curves, calculation, or table (If available)	Only applicable if the pressure system contains pumps or compressors		

General Legacy Pressure System Description for Oxygen

Evaluation Category 7

Assumptions:

Fluid Service

1. The system fluid service is FS2 or FS3 as defined by ESM Chapter 17
2. Materials of construction are compatible with the oxygen at the design pressure.

System Operation

1. The pressure system does not operate in the creep range.
2. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).
2. Fire is an evaluated failure mode.

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These oxygen pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These oxygen pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance and cleaned as required by ESM Chapter 17 as items age out of service by attrition.

4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-G include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. These oxygen pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the oxygen pressure system they must be evaluated for current MAWP based on the most applicable code or standard.
8. Oxygen system hazards analysis that defines the areas of potential fire and any necessary safe guarding.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

Consequence			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 ADMIN-1-3-G

General Legacy Pressure System Documentation for Oxygen

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[83]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[83] Information required on Form 10, 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

Table ADMIN-1-3-G

General Legacy Pressure System Documentation for Oxygen

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. FM07	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		
9. Oxygen System Hazard Analysis (if applicable)	Pressure system is an oxygen system		

General Legacy Pressure System Description for Flammables

Evaluation Category 8

Assumptions:

Fluid Service

1. The system fluid service is a FS2 as defined by ESM Chapter 17
2. The pressure system fluid service is Normal as define by ASME B31.3 2010.
3. Materials of construction are compatible with the system fluid service.
4. Flammable is defined in accordance with NFPA 55 *Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks* and CGA P-23 *Standard for Categorizing Gas Mixtures Containing Flammable an Nonflammable Components*.

System Operation

1. The pressure system does not operate in the creep range.
2. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These flammable pressure systems shall be exempt from the requirements of having code leak test documentation.

2. These flammable pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-H include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Piping shall be of known or verified wall thickness (FM06).
6. These flammable pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
7. When vessels are included as part of the flammable pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-H

General Legacy Pressure System Documentation for Flammable Gases

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, System schematics (If the owner does not have a system schematic, utilize the sketch prepared by the walk down team until such time as system schematic is prepared)[12]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every package		
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)		

[12] Information required on Form 10, 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

Table ADMIN-1-3-H

General Legacy Pressure System Documentation for Flammable Gases

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. Form 06, Piping thickness and remaining life estimate	Every Package		
b. Form 07	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Cryogenic Liquids (Helium, Neon, Argon, Krypton, Xenon, Nitrogen, Oxygen, Air)

Evaluation Category 9

Assumptions:

Fluid Service

1. The system fluid service is a FS2 as defined by ESM Chapter 17
2. The pressure system fluid service is Normal as define by ASME B31.3 2010.
3. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
2. Pressure is limited to 150 psig.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that may be isolated from relief protection with cryogenic liquid present.
4. System is constructed of metallic components with materials rated in the ASME B31.3 Table A-1 for the cryogenic temperatures.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.
7. Flexible elements are rated for the cryogenic temperatures.
8. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
9. Insulation is adequate to preclude the formation of liquid air.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These cryogenic liquid pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These cryogenic liquid pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-J include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Existing cryogenic liquid systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
6. When vessels are included as part of the cryogenic liquid pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-J

General Legacy Pressure System Documentation for Cryogenic Liquids

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[13]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[13] Information required on Form 10, 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

Table ADMIN-1-3-J

General Legacy Pressure System Documentation for Cryogenic Liquids

Documentation Package Item	Required When	Owner Verification	PSO Verification
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		
a. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
d. Identification as a liquid lock PRD on PRV Recall Summary Sheet and pressure system Component List spread sheet.	PRD's are used as protection against liquid lock overpressure		
e. Identification as vacuum insulation relief device	PRD's are used as protection against vacuum system overpressure		
7. Piping System Documentation:			
a. Form 7; Manufacturer's data indicates component is within temperature and pressure operational specifications	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Steam Condensate

Evaluation Category 10

Assumptions:

Fluid Service

1. The system fluid service is a FS3 as defined by ESM Chapter 17

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
2. Pressure is limited to 150 psig.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Steam condensate systems are effectively isolated from steam lines for example steam traps.
5. System is constructed of metallic components and pipe.
6. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
7. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These steam condensate pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These steam condensate pressure systems may continue to use unlisted components,
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.

4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-K include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Existing steam condensate pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
6. When vessels are included as part of the steam condensate pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Minor

QR Factor: 5

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-K

General Legacy Pressure System Documentation for Steam Condensate

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[14]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[14] Information required on Form 10, 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

Table ADMIN-1-3-K

General Legacy Pressure System Documentation for Steam Condensate

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. FM07; for available components	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Compressed Air with Receiver

Evaluation Category 11

Assumptions:

Fluid Service

1. The system fluid service is a FS2 or FS3 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is Normal as define by ASME B31.3 2010.
   1.2. The pressure systems are within the scope of ASME B31.9-2011.
2. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.
2. Pressure is limited to 150 psig.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. System is constructed of metallic components, pipe, and tube.
6. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
7. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These compressed air with receiver pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These compressed air with receiver pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.

3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-M include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Existing compressed air with receiver pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
6. When vessels are included as part of the compressed air with receiver pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-M

General Legacy Pressure System Documentation for Compressed Air with Receiver

Documentation Package Item	Comment	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[15]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[15] Information required on Form 10, 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

Table ADMIN-1-3-M

General Legacy Pressure System Documentation for Compressed Air with Receiver

	Documentation Package Item		Comment	Owner Verification	PSO Verification
	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.	Vessel thickness and remaining life estimate	Every Package		
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, 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		
7.	Piping System Documentation:				
	a.	FM07; for available components	Every Package		
8.	Pump or compressor discharge pressure curves, calculation, or table (If available)		Only applicable if the pressure system contains pumps or compressors		

General Legacy Pressure System Description for Compressed Inert Gases – DOT Cylinders

Evaluation Category 12

Assumptions:

Fluid Service

1. The system fluid service is FS2 or FS3 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is Category D as define by ASME B31.3 2010.
   1.2. The pressure system fluid service is Category Normal as define by ASME B31.3 2010.
2. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. System is constructed of metallic components.
6. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
7. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These Compressed Inert Gases – DOT Cylinders pressure systems shall be exempt from the requirements of having code leak test documentation.

2. These Compressed Inert Gases – DOT Cylinders pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-N include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Existing Compressed Inert Gases – DOT Cylinders pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
6. When vessels are included as part of the Compressed Inert Gases – DOT Cylinders pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: 5

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
Consequence			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 ADMIN-1-3-N

General Legacy Pressure System Documentation for Compressed Inert Gases – DOT Cylinders

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[16]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		
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)		

[16] Information required on Form 10, 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

Table ADMIN-1-3-N

General Legacy Pressure System Documentation for Compressed Inert Gases – DOT Cylinders

Documentation Package Item	Required When	Owner Verification	PSO Verification
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. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
b. FM07; for available components	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for Compressed Air without Receiver

Evaluation Category 13

Assumptions:

Fluid Service

1. The system fluid service is FS2 or FS3 as defined by ESM Chapter 17
    1.1. The pressure system fluid service is Category D as define by ASME B31.3 2010.
    1.2. The pressure system fluid service is Category Normal as define by ASME B31.3 2010.
    1.3. The pressure systems are within the scope of ASME B31.9-2011.
2. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17.
5. System is constructed of metallic components.
6. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
7. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These compressed air pressure systems shall be exempt from the requirements of having code leak test documentation.

2. These compressed air pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-P include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).

Qualitative Risk Assessment

Probability: Remote

Consequence: Minor

QR Factor: 4

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-P

General Legacy Pressure System Description for Compressed Air without Receiver

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[89]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
5. Piping System Documentation:			
a. FM07; for available components	Every Package		
6. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

[89] Information required on Form 10, 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

General Legacy Pressure System Description for Compressed Inert Gases – Building Systems

Evaluation Category 14

Assumptions:

Fluid Service

1. The system fluid service is a FS3 as defined by ESM Chapter 17
   - 1.1. The pressure system fluid service is Category D as define by ASME B31.3 2010.
   - 1.2. The pressure system fluid service is Category Normal as define by ASME B31.3 2010. (liquids)
   - 1.3. The pressure systems are within the scope of ASME B31.9-2011.
2. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. System is constructed of metallic components.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These Compressed Inert Gases – Building pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These Compressed Inert Gases – Building pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer’s.

3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-R include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).
5. Existing Compressed Inert Gases – Building pressure systems may continue to use non-ASME stamped vessels provided calculations are performed to verify code-equivalent ratings.
6. When vessels are included as part of the Compressed Inert Gases – Building pressure system they must be evaluated for current MAWP based on the most applicable code or standard.

Qualitative Risk Assessment

Probability: Remote

Consequence: Minor

QR Factor: 5

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-R

General Legacy Pressure System Documentation for Compressed Inert Gases - Buildings

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[18]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Code Stamped Vessel Fabrication Documentation	If the code data report is not available, a manufacturer's construction drawing may be used to verify the item has not been modified. 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.		
a. Vessel thickness and remaining life estimate	Every Package		

[18] Information required on Form 10, 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

Table ADMIN-1-3-R

General Legacy Pressure System Documentation for Compressed Inert Gases - Buildings

Documentation Package Item	Required When	Owner Verification	PSO Verification
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 or accumulator is in the pressure system package		
b. Vessel thickness and remaining life estimate	Every Package		
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. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
7. Piping System Documentation:			
a. FM07; for available components	Every Package		
8. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

General Legacy Pressure System Description for High Pressure – Low Liquid Volume

Evaluation Category 15

Assumptions:

Fluid Service

1. The system fluid service is a FS1 liquid with a low flow liquid rate such that whipping of flex lines is not an issue.
   1.1. The pressure system fluid service is High Pressure as define by ASME B31.3 2010.
   1.2. The fluid used is not toxic, corrosive, or immediately dangerous to humans.
2. Materials of construction are compatible with the system fluid service.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig are restrained in accordance with ESM Chapter 17 only in locations where adequate volume is present to present a whipping problem.
5. Pumping rates are low enough to preclude hose whipping and fluid jetting from leaks.
6. System is constructed of metallic components.
7. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
8. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Existing (including Legacy) System Documentation Requirements

Documentation Requirements

1. These High Pressure – Low Liquid Volume pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These High Pressure – Low Liquid Volume pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-S include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).

Qualitative Risk Assessment

Probability: Remote

Consequence: Significant

QR Factor: Insignificant

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	B	C	D	E
			Frequent	Probable	Occasional	Remote	Improbable
Consequence	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 ADMIN-1-3-S

General Legacy Pressure System Documentation for High Pressure – Low Liquid Volume

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, System schematics (If the owner does not have a system schematic, utilize the sketch prepared by the walk down team until such time as system schematic is prepared)[19]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
5. Piping System Documentation:			
a. FM07; for available components	Every Package		
6. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

[19] Information required on Form 10, 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

General Legacy Pressure System Description for Hydronic Piping

Evaluation Category 16

Assumptions:

Fluid Service

1. The system fluid service is FS3 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is Category D as define by ASME B31.3 2010.
   1.2. The pressure systems are within the scope of ASME B31.9-2011.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. System is constructed of metallic components.
5. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
6. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These hydronic pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These hydronic pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer’s.
3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.

4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-T include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).

Qualitative Risk Assessment

Probability: Remote

Consequence: Minor

QR Factor: 5

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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 ADMIN-1-3-T

General Legacy Pressure System Documentation for Hydronic Piping

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 10, 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)[20]	Every Package		
3. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
4. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
5. Piping System Documentation:			
a. FM07; for available components	Every Package		
6. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

[20] Information required on Form 10, 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

General Legacy Pressure System Description for Water Systems

Evaluation Category 17

Assumptions:

Fluid Service

1. The system fluid service is FS3 as defined by ESM Chapter 17
   1.1. The pressure system fluid service is Category D as define by ASME B31.3 2010.
   1.2. The pressure systems are within the scope of ASME B31.9-2011.

System Operation

1. There are no stress intensification factors for example cracks or acute angles of pressure boundaries.

System Hardware

1. The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned components of the same or like material.
2. The system is equipped with a properly sized, set, and functional pressure relief device(s), if needed, to protect against single point failures. Relief device exhaust locations are properly sized and located to protect personnel.
3. There are no locations in the system that requires relief protection that may be isolated from relief protection.
4. System is constructed of metallic components.
5. External appearance is free from corrosion or indication of leakage.
6. In response to the PISA on LANL Welding Program (circa 2004) representative accessible welds were visually inspected and are free from indications. Solder or braze joints are not allowed.
7. External appearance is free from corrosion or indication of leakage.

Failure Mode

1. A ductile failure mode is assumed (leak before burst).

Consequence of Failure

1. The result of the failure will not result in serious personnel injury. Safe-guarding will be applied if necessary.

Safety Class

1. Applicable to ML4 only.

Documentation Requirements

1. These water pressure systems shall be exempt from the requirements of having code leak test documentation.
2. These water pressure systems may continue to use unlisted components provided they are used within the temperature and pressure ratings of the manufacturer's.

3. This equipment will be considered grandfathered and will not be replaced with like items. System shall be upgraded to ASME compliance as items age out of service by attrition.
4. LANL ESM Chapter 17 documentation as required by Table ADMIN-1-3-U include: certification status form (FM01), relief device (FM02), component list (FM07), and sketch (FM10).

Qualitative Risk Assessment

Probability: Remote

Consequence: Insignificant

QR Factor: 6

Table 3 Qualitative Risk (QR) Determination

			Probability				
			A	**B**	**C**	**D**	**E**
			Frequent	**Probable**	**Occasional**	**Remote**	**Improbable**
Consequence	**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

Existing (including Legacy) System Documentation Requirements

Table ADMIN-1-3-U

General Legacy Pressure System Documentation for Water Systems

Documentation Package Item	Comment	Owner Verification	PSO Verification
1. Form 1, LANL Pressure System Certification Status Form	Every Package		
2. Form 7, Component List	Every Package		
3. Form 10, 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)[21]	Every Package		
4. Alternate Method/Variance or clarification/interpretation (if applicable).	If the system or any item of the system has an applicable alternate method/variance or clarification/interpretation to the requirements of this document		
5. Pressure Safety Devices	The pressure system contains a pressure safety device (which includes but is not limited to relief valves and rupture discs)		
a. 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.		
b. Pressure Relief Calculations for Rupture Disks in accordance with ASME requirements	Rupture Disks are in the pressure system		
c. 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		
6. Piping System Documentation:			
a. FM07; for available components			
7. Pump or compressor discharge pressure curves, calculation, or table (If available)	The pressure system contains pumps or compressors		

[21] Information required on Form 10, 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

New System Document Requirements

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Documentation Package Item	Required When	Owner Verification	PSO Verification
1. All forms contained in Attachment ADMIN-1-1 of this standard[1]	Every Package		
2. System drawings and schematics[2]	Every Package		
3. Alternate Method/Variance (if applicable)	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)		

[1] Information required on the forms 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

[2] 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
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		
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		

Documentation Package Item	Required When	Owner Verification	PSO Verification
g. Identification as a liquid lock PRD on PRV Recall Summary Sheet and pressure system Component List (e.g., 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.		
b. Pressure Qualification Test Procedures and data as defined by the applicable piping code	A pressure system package contains piping system components		
c. Examiner qualification	Examinations are preformed		
d. Owner's Inspector Checklist	Every package		
e. Modification procedures/instructions	Components of a system were modified from original construction		
f. Non-Destructive Evaluation (NDE) data reports	NDE is performed on piping system components		
g. 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.		
h. Corrosion allowance calculations per ASME B31G	Piping is used in corrosive fluid service		
i. 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		
j. 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		
k. Weld In-Process Forms in accordance with ESM Chapter 13, and the most applicable code.	When in-process examination of welding is used		
l. Vendor Drawings or sketches	A pressure system package contains vendor supplied systems, piping, or components		
m. Manufacturers' data sheets	Using component is pressure system		
n. Unlisted Component Evaluation	Using a non-listed component in pressure system		
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		

Pressure System Owner Checklist

for New or Modified Systems

(Guidance)

<u>Before Design</u>

- ☐ Select applicable ASME code for design and fabrication (consult with PSO)
- ☐ Select qualified Pressure System Designer

<u>During Design</u>

- ☐ Establish system design conditions (e.g., temperature, pressure, flow, ambient effects, dynamic effects)
- ☐ Perform system design calculations in accordance with applicable ASME B31 piping code

<u>Before Fabrication</u>

- ☐ Designate qualified Examiner and establish Examiner witness and hold points
- ☐ Engage qualified Owner's Inspector and establish Inspector witness and hold points
- ☐ Procure listed piping components in accordance with applicable ASME B31 piping code (or obtain variance using request)
- ☐ Procure pressure vessels in accordance with ASME B&PV Code, Section VIII (or obtain variance by request)

<u>During Fabrication</u>

- ☐ Utilize qualified personnel for performance of fabrication steps (e.g., qualified welders or compression fitting assemblers)
- ☐ Perform examinations and inspections as agreed with examiner and inspector

<u>Before Operation</u>

- ☐ Perform leak test in accordance with applicable ASME B31 piping code
    - o Ensure that instrumentation has been calibrated
    - o Ensure that Owner's Inspector is present to witness test
    - o Contact PSO to review documentation package and obtain system certification

<u>During Operation</u>

- ☐ Ensure that personnel operating the system have received applicable institutional training in accordance with P101-34
- ☐ Establish periodic maintenance requirements in accordance with ESM Chapter 17

Risk-Based Certification Processing and Maintenance (Guidance)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

A phased approach should be implemented with regard to certification of existing pressure systems.

Priority should be given provide the highest level of risk reduction in pressure systems in accordance with Table ADMIN-1-6 below. The implementation of the pressure safety preventive maintenance process at LANL is risk-based.

With regard to maintenance:

1. The maintenance periods defined in Section ADMIN-4 *Inspection and Testing* articles on Inspection/Testing Interval and Corrosion and Remaining Life are postponed until the risk-based implementation of the pressure safety preventive maintenance process at LANL is complete for a specific system.

    a. As each pressure system receives initial maintenance and moved into a preventative maintenance program the maintenance intervals of articles on Inspection/Testing Interval and Corrosion and Remaining Life will be applied.

2. Implementation of pressure safety preventive maintenance should emphasize the graded approach of reducing the risk based on the nature of the fluid and the type of hazard; those that pose the greatest risk should be implemented first. Risk-based implementation of the preventive maintenance process at LANL will be to process systems based on the order established in the table. Those systems defined as “High” risk should be implemented first. After the “High” risk, “Medium” and “Low” risk implementation will follow in that order. Where specific conditions of the pressure system warrant the category of risk implementation may be changed with approval from the CPSO and the Safety Management Program Owner.

3. It is the responsibility of the FOD or RAD to ensure the safety of pressure systems, and implementation of the ESM Chapter 17 maintenance requirements.

   a. Implementation of the pressure safety preventive maintenance cycle should include the following:

      1) Verification of adequacy of safety devices and archival of the data in the pressure safety package.

      2) Initial servicing of relief devices.

      3) Wall thickness measurements for remaining life evaluation (for vessels and piping as appropriate).

      4) Tagging of all relief devices and vessels in accordance with ESM Chapter 1 Section 200.

      5) Release of a CMMS preventative maintenance work order (with cost codes) for non-programmatic systems.

      6) Implementation of a centralized data repository for the maintenance process for relief devices and vessels in programmatic systems.

Table ADMIN-1-6: Pressure Safety Maintenance Implementation Plan

Type of Pressure System	Risk-Based Pressure System Ranking
SC/SS (ML1/ML2)	High
High Pressure – Pneumatic	
Toxics (Category M)	
Steam	
High Pressure – Liquid High Volumetric Rate	

Type of Pressure System	**Risk-Based Pressure System Ranking**
Corrosive[1]	Medium
Brittle Failure Mode (not leak before burst)	
Oxygen[2]	
Flammables	
Cryogenic Liquids	
Steam Condensate	
Compressed Air with Receiver	
Compressed Inert Gases – DOT Cylinders	

Type of Pressure System	**Risk-Based Pressure System Ranking**
Compressed Air Without Receiver	Low
Compressed Inert Gases – Building Systems	
High Pressure –Low Liquid Volume	
Hydronic piping	
Water Systems	

[1] 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.

[2] Evaluate oxygen systems as required in ASTM G128 and other referenced ASTM standards to determine the likelihood of fire.

Table of Contents

1.0 DESIGN AND DOCUMENTATION 3

A. Calculations 3

B. Cryogenic Systems 3

C. DOT Vessels 4

D. Drawings and Sketches 4

E. Finite Element Analysis and Other Software 5

F. Fitting and Fastener Assembly 5

G. Flexible Hoses and Tubing 6

H. Restraints for Flexible Hoses and Relief Device Discharge Tubing 6

I. Fluid Category Determination 8

J. Gas Cylinder Pressure Systems 8

K. Hydrogen and Flammable Fluid Pressure Systems 10

L. Instruments 11

M. Liquid lock 11

N. Material Compatibility 12

O. Oxygen Systems 16

P. Piping and Tubing 16

Q. Piping Components 17

R. Piping Flanged Joint Connection Assembly 18

S. Piping Supports and Flexibility Analysis 18

T. Pressure Relief Requirements 19

U. Pressure Vessel Requirements 23

V. Radioactive Liquid Waste (RLW) 25

W. System Interactions 25

X. Vacuum and Externally Pressurized Components and Piping 25

Y. Vent Systems 26

Z. Unlisted, Specialty, or Unique Components 26

AA. Welding Systems 28

BB. Welding Design 28

2.0 COMPUTER RECORDS 29

A. General 29

B. CMMS Database 29

C. DMAPS 29

D. Pressure Safety Certification Storage (PSCS) 29

ATTACHMENTS 30

Attachment ADMIN-2-1, Relief Device Selection Process for Gas Bottle Systems (Guidance) 30

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

1.0 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.).[1]
2. Calculations for utility and facility systems, including welding calculations, must be performed per AP-341-605, Calculations (or LANL-approved equivalent), and ESM Chapter 1 Section Z10 (re: Design Output Documentation) and must be maintained in the pressure system documentation package.
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, Division 1 Part UG-125) of the system MAWP.[2]
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 and API 521 for pressure systems with supplied pressure. Flow test must be documented and maintained in the pressure system documentation package.
5. Calculations of relief devices shall be based on single-point-failure analysis. In the case of a pressure regulator this requires assuming the regulator fails fully open (regulator Cv used to calculate flow) and the flow exiting from the regulator must be matched by a relief device capable of relieving sufficient flow that the accumulation pressures meets code requirements typically less than or equal to 10% overpressure. For example a relief device set pressure is 100 psig. The relief device must flow sufficient amount of material to prevent the system pressure from exceeding 110 psig.

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 shall not be used.[3]

[1] Relief devices are rated in US units; eliminates conversion errors.
[2] See ASME Section I and IV for boiler-specific capacity allowances
[3] The extreme low temperatures will cause the hoses to become brittle, increasing the risk of rupture and leakage

4. Flexibility analysis (as defined in the most applicable piping code)[4] 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 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).

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, see Ch. 17 Section NASME (*para. 2.0, DOT, IM, and UM Portable Tanks*).

    Guidance: Vessels less than 6" ID are considered piping components, not pressure vessels.[5]

D. Drawings and Sketches

1. Design information required by this chapter, where appropriate, may alternatively be captured in other documents or in controlled databases, such as the electronic document management system (EDMS) 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.

[4] For example, see B31.9 Chapter 2 Part 5 or ASME B31.3 Paragraph 319.
[5] ASME B&PV Code Section VIII (e.g., Div 1, UG-1)

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.

   a. *Drawings and sketches should comply with AP-341-608, Engineering Drawings and Sketches, the LANL CAD Manual, or LANL-approved equivalent*.

4. Fluid components must be identified using the identification system established in ESM Chapter 1, Section 200, "Numbering and Labeling".

5. Diameters, wall thickness, and material type of all tubing and piping used in the system must be shown.

6. Sketches specific for relief device calculations must show all dimensions required to generate the calculation.

7. 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.

8. 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 LANL policy P1040 and DOE O 414.1 *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. A published specification or controlled standard

b. Manufacturer standards based on the joint design and all materials of construction.

c. Special calculations by the designer.

G. Flexible Hoses and Tubing

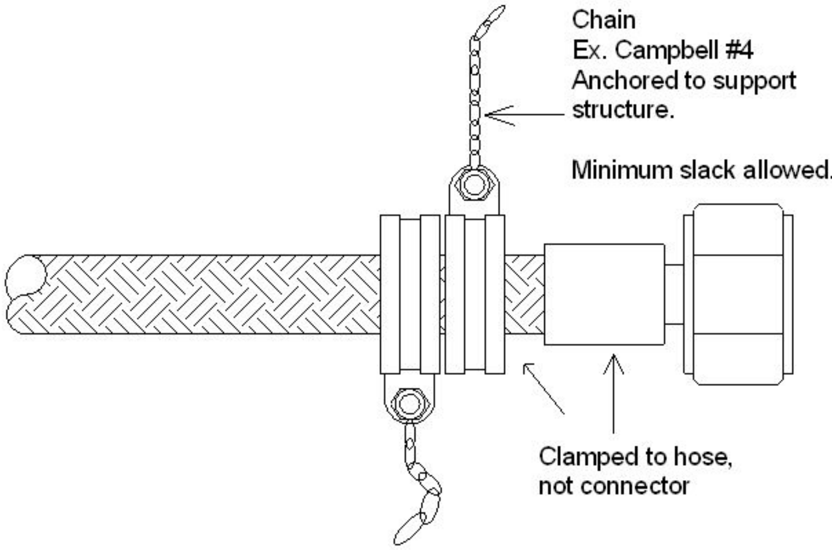
1. All preassembled flexible hoses must be procured from the manufacturer with the MAWP stamped, etched, or tagged on the hose or end connectors indicating the maximum allowable working pressure of the assembly.
2. Flexible hose assemblies without manufacturer's MAWP indicated on the hose/flexible tubing 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. Consider material compatibility per NFPA 30 and 45
5. Flexible "Poly-flo" type 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*).
6. "Poly-Flo" or similar non-metallic tubing must comply with ASME B31.3, Chapter VII.
7. Flexible hoses must be installed and used in such a manner as to prevent kinking and to minimize torsion, axial loads, twisting, and abrasion.
8. Several Swagelok flexhoses (*FM, FJ, FL, T, X, S, C, N, W, F, and U*) are approved for use at LANL; see Chapter 17 Attachment ASME-4-2 Swagelok Flexhose.

H. Restraints for Flexible Hoses 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.[6]
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. Hoses inside glove-boxes where whipping poses no personnel danger are considered adequately shielded for the hazard. 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

[6] 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.

separation unless an adequate alternative for personnel protection is provided. Example shown below:[7]



Hubbell Kellums grips

5. Flex tubing/hoses located inside glove boxes, equipment, or test setups where whipping poses no nuclear safety or personnel danger are exempt from requirements for flexible element restraints.

[7] Flexible element restraints concepts throughout this section: WSTF WSI-SW-0024.B (NASA White Sands Test Facility Standard Instruction), industry standard, and lessons learned.

6. Specifically excluded are free-rotating/translating systems whose designs prohibit securing at 6-ft intervals.

7. Section ASME Attachment ASME-4-1 contains information on allowable hose restraints and methods for calculating the force from a line failure.

I. 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).

   a. *The CPSO may evaluate the fluid service of a pressure system on an individual basis to determine if they meet Fig. M300 in B31.3 even if listed in ESM Chapter 17 Section II Attachment II-3 Category M fluids, and will consider relevant information in the evaluation, including protection of personnel against exposure. One of the relevant criteria is protection of personnel against exposure during system operation. A record of successful service may be created by the Industrial Hygiene and Deployed Services Group (IHS-IH) documenting the historical exposure record for the system confirming that personnel have been protected against exposure.*

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 chapter 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,” Chapter 17 REF-3.

J. Gas Cylinder Pressure Systems

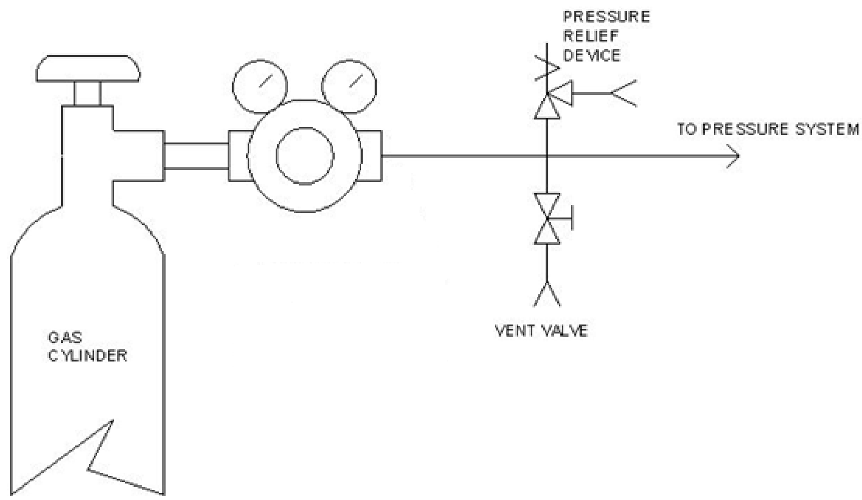
1. Pressure systems utilizing pressurized cylinders as the pressure source must meet all the applicable requirements of this document, including certification.[8]

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.

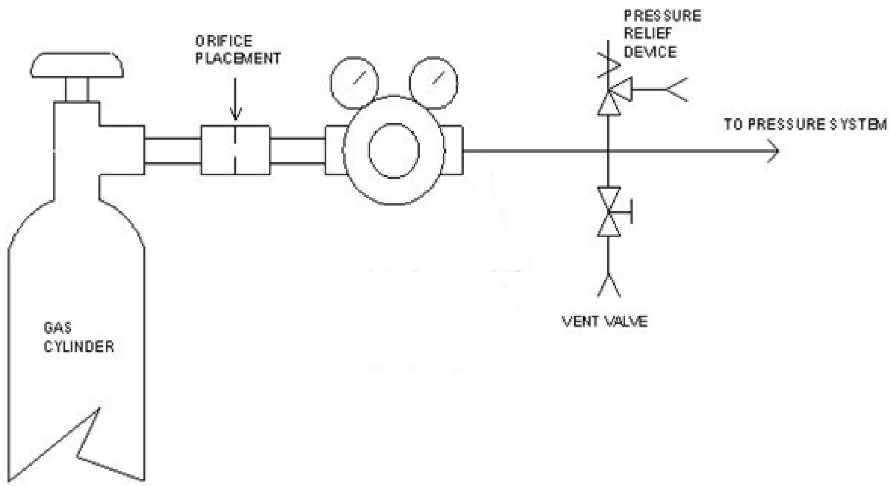
---

[8] 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.

3. Orifices used must be rated for full bottle pressure.
4. Cylinders must be braced, chained, in place to prevent toppling.
5. Gas cylinders must have a pressure safety manifold system incorporated into the design after the regulator as shown below (note in some cases the vent valve and relief device may not be allowed to vent locally for example when a flammable or toxic material is used):



6. 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 downstream (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 (note in some cases the vent valve and relief device may not be allowed to vent locally for example when a flammable or toxic material is used).



7. *The same orifice may be placed after the regulator, but may present operational issues since the orifice restriction may decrease operational flowrates*. In addition, all items between the regulator and the orifice must be suitable for upstream bottle pressure (in the event a regulator fails open). This would include the gauge in the sketch above.

8. *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.*

9. 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.

10. 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.

11. 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.

12. *Guidance for selection of pressure relief devices for gas cylinder pressure systems is provided in Attachment ADMIN-2-1, Relief Device Selection Process for Gas Bottle Systems.*

K. 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.

L. 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.
    b. Tempered safety glass or plastic face or shield 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.*
6. Labeling and Tagging of Components
    a. 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."
    b. 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.[9]

d. An engineering evaluation is required for liquid lock relief valves.

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. Select materials 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

1) *Systems that with passive corrosion (aluminum oxide, fluorine systems) should not be disturbed. Care should be taken to re-establish the passive corrosion layer*.

2) 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)*

[9] ASME B31.3 Chapter II, Part 6, paragraph 322.6.3

e. Corrosion effects shall be considered by the designer for the fluid service and the temperature and pressure of the fluid service:

1) 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

2) The possibility of adverse electrolytic effects if the metal is subject to contact with a dissimilar metal

3) The effect of stress corrosion

4) The effect of intergranular corrosion (austenitic stainless steel carbide precipitation and chromium depletion)

5) The effect of hydrogen embrittlement

6) The effect of pitting corrosion

7) The effect of Microbiologically Influenced Corrosion

8) The possible corrosion under insulation effect

9) The effect of erosion corrosion

10) The effect of environmental cracking

11) The effect of electrolytic corrosion

12) The effect of selective corrosion attack on structural constituents

13) The effect of exfoliation corrosion

14) The effect of interfacial corrosion

f. Stress Corrosion Cracking

1) Stress corrosion cracking (SCC) is the cracking induced from the combined influence of tensile stress and a corrosive environment. The impact of SCC on a material usually falls between dry cracking and the fatigue threshold of that material. The required tensile stresses may be in the form of directly applied stresses or in the form of residual stresses, see an example of SCC of an aircraft component. The problem itself can be quite complex. The situation with buried pipelines is a good example of such complexity.

2) Cold deformation and forming, welding, heat treatment, machining and grinding can introduce residual stresses. The magnitude and importance of such stresses is often underestimated. The residual stresses set up as a result of welding operations tend to approach the yield strength. The build-up of corrosion products in confined spaces can also generate significant stresses and should not be overlooked. SCC usually occurs in certain specific alloy-environment-stress combinations.

3) Usually, most of the surface remains unattacked, but with fine cracks penetrating into the material. In the microstructure, these cracks can have an intergranular or a transgranular morphology. Macroscopically, SCC fractures have a brittle appearance. SCC is classified as a *catastrophic form of corrosion, as the detection of such fine cracks can be very difficult and the damage not easily predicted. Experimental SCC data is notorious for a wide range of scatter. A disastrous failure may occur unexpectedly, with minimal overall material loss.*

g. *Chloride Stress Corrosion Cracking - CSCC*

1) *Chloride Stress Corrosion Cracking is a localized corrosion mechanisms like pitting and crevice corrosion. The three conditions that must be present for chloride stress corrosion to occur are as follows.*

- *Chloride ions are present in the environment*
- *Dissolved oxygen is present in the environment*
- *Metal is under tensile stress*

2) *Austenitic stainless steel is a non-magnetic stainless steel grades consisting of iron, chromium, and nickel, with a low carbon content. This alloy is highly corrosion resistant and has desirable mechanical properties. One type of corrosion which can attack austenitic stainless steel is chloride stress corrosion. Chloride stress corrosion is a type of intergranular corrosion. Chloride stress corrosion involves selective attack of the metal along grain boundaries. In the formation of the steel, a chromium-rich carbide precipitates at the grain boundaries leaving these areas low in protective chromium, and thereby, susceptible to attack. It has been found that this is closely associated with certain heat treatments resulting from welding. This can be minimized considerably by proper annealing processes.*

3) *This form of corrosion is controlled by maintaining low chloride ion and oxygen content in the environment and the use of low carbon steels. Environments containing dissolved oxygen and chloride ions can readily be created in auxiliary water systems.*

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 and 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, effect 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.

6. For oxidizer fluid or fluorine service, special cleaning and inspection is required to 175A or better as defined in ASTM G93 (*para. 11.4.3).*

7. Low Temperature

a. At operating temperatures below −191°C (−312°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.

8. 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.

9. Hydrogen, Deuterium, and Tritium Service

a. Systems in hydrogen, deuterium, or tritium service shall follow ASME B31.12.

b. Tritium system design shall consider DOE-HDBK-1129, Tritium Handling and Storage.

10. 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.

11. 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.

12. 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.*

13. Acetylene

a. In all cases, copper, silver, and mercury must 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, poltytetrafluoroethylene (PTFE), polychlorotrifuoroethylene (PCTFE), polyamide (PA), natural and synthetic rubbers, and leather.*

c. Use of cast iron and semi-steel that 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. Oxygen systems shall be designed (including materials selection), tested, cleaned, and assembled in accordance with ASTM G128 and other referenced ASTM standards. The design, testing, cleaning, and assembly shall be documented as an oxygen hazards analysis and shall be approved by the CPSO. The system shall be evaluated to reduce the likely hood of fire."

2. Design systems used for oxygen/oxidizer service to NFPA 55.

3. 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.

4. Follow ESM Chapter 2 to 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. 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.

   Guidance: Use of seam-welded pipe or tubing is strongly discouraged.

Q. Piping Components

1. See Section GEN-1 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.

a. Records of acceptable components and evaluations shall be kept by the CPSO and made available to all LANL employees.

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 Instrumentation heading above.

4. Pressure systems must have all major components (flex-hoses, 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 (316 stainless, brass, etc.)

R. Piping Flanged Joint Connection Assembly

1. Follow the most applicable 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

S. Piping Supports and Flexibility Analysis

1. Follow B31.3 Process Piping for piping supports. Guidance: LANL B31.3 Process Piping Guide is also available as an attachment to this Section.

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.

1) 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 incorporate flexibility which is necessary to accommodate thermal expansion/contraction.

3. Additional requirements for anchoring are in ESM Chapter 5 Structural[10] and Master Specifications 22 0529 *Hangers and Supports for Plumbing, Piping, and Equipment*; 22 0548 *Vibration and Seismic Controls for Plumbing, Piping, and Equipment; and* 13 4800 *Sound, Vibration and Seismic Control*. When a system is not required to be rated for seismic service, no seismic evaluations are required.

T. Pressure Relief Requirements

1. Pressure vessels and piping must have protection against over-pressurization.

a. Maximum inlet piping pressure drop must be in accordance with ASME Section VIII, Div 1, Part M-6 and Div II, Section 9.

2. 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.

3. 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.

4. 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.[11]

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.[12]

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.[13]

[10] ESM 5 based on ASCE-7, DOE 420.1-1A, DOE Standard 1020, etc.
[11] See ASME B&PVC Section I and IV for boiler-specific capacities.
[12] 1997 IAPMO UMC, Section 1008. The referenced mechanical drawing provides piping detail for steam safety valves and additional design criteria.

5. Pressure relief devices must have calculations meeting 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, Div. 1 part UG-125) of the MAWP of the component it is protecting during maximum fault conditions (see Exclusions section).

6. 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.

7. 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.

8. 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 Division 1.

9. 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 (e.g., UG-140 may be used to substantiate the safety of the vessel).

10. Pressure relief designs must include a calculation report that includes at least, but not limited to the following (for rupture disks adjust as appropriate):

    a. Manufacturer

    b. Model number

    c. Inlet size and type

    d. Outlet size and type

    e. Set/burst pressure (psig)

    f. Service fluid

    g. Relieving capacity

    h. Relieving capacity at overpressure percent[14]

    i. Orifice trim (Not applicable to rupture disks)

    j. ASME Code Section

---

[13] Ibid.

[14] Allowable percentage as defined by ASME Section VIII, Division 1 Parts UG-125 through UG-136, or ASME Section I and IV.

k. Blow down (if critical, not required for rupture disks)

l. Determination of pressure relief device sizing

m. Determination of required relieving flow

n. Determination of inlet/outlet pressure drop at relieving conditions.

11. 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).[15]

12. 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).

13. 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.

14. 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."[16]

15. 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.[17]

16. When performing a B31.3 345.5.3 Leak Test the test system must be protected by a relief device. If the owner's representative approves a pneumatic leak test and the test rig has a pressure relief that will not exceed the any components MAWP then the system shall be considered as satisfactorily protected.

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 a least 10 psi, or 25 percent of the boiler operating pressure, whichever is greater.[18]

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. [19]

---

[15] Not a requirement for devices protecting only B31 piping systems.
[16] 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.
[17] ASME Section VIII, Division 1 Part UG-125 (c)(3)(a). See API 521 for calculations.
[18] NB-23, National Board Inspection Code, Appendix F.
[19] Ibid.

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. 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[20] (typically 110% above the MAWP), when allowed/approved by CPSO.[21]

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.

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.

i. System must not be allowed to operate until provisions have been made to accommodate for required relief capacity as defined by ASME Section VIII, Div. 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

[20] See also ASME B&PVC Section I and IV for boiler specific applications

[21] 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

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 (manufacturer or calibration lab).

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:[22]

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.

U. Pressure Vessel Requirements

1. When U-1 or U-1A documentation reports cannot be obtained for pressure vessels, pressure vessel calculations (as defined by ASME B&PVC Section VIII) are required to be generated using LANL AP-341-605 or CPSO-approved equivalent procedure.

2. Pressure vessels, in a pressure system, that fall under the scope of ASME Section VIII, must be ASME stamped, NBIC numbered and 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.

[22] See ASME Section VIII Div 1 Part UG-135(d), and B31.3 paragraph 322.6.1

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. 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 designee 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.

8. 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.

9. Cryogenic Vessels

    a. The internal portion of a stationary cryogenic vessel shall meet ASME Boiler and Pressure Vessel Code Section VIII.

    b. The vacuum jacket may also meet the ASME Boiler and Pressure Vessel Code Section VIII or other suitable commercial standards such as:

1) CGA 341, Specification for Insulated Cargo Tank for Nonflammable Cryogenic Liquids

2) CGA H-3, Cryogenic Hydrogen Storage

3) NFPA 55, Compressed Gases and Cryogenic Fluids Code

V. Radioactive Liquid Waste (RLW)

1. The Owners' representative, the Chief Engineer, has directed that (as of July 18, 2014) all new RLW system designs or new modifications to existing RLW systems be treated as ASME B31.3 Fluid Category Normal (not "D') as the default minimum. Systems or system modifications started before this date may be completed under the existing design.

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*

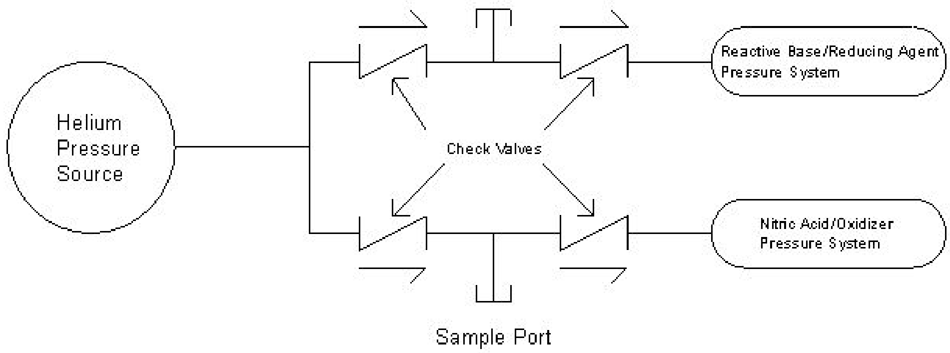
   b. *Where two dissimilar systems must be continuously pressurized from a single pressure source.*

   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, Div 1 parts UG-28 thru UG-30 (vessels under external pressure).[23]

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.[24]

4. Relief devices and vents 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 Components25

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 and ASME B31.1 requires a safety factor of 4:1. For existing systems, refer to Chapter 17 Section EXIST.

a. Swagelok components (tubing, fittings, and valves only) are allowed for use in construction of new, code-compliant systems at LANL.[26] See Section Attachment ASME-4-2 for flex hose.

2. The master list of Unlisted Components allowed for use is maintained by the CPSO and made available for both internal and external web access.

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 (per the code of record) as follows (B31.3 302.2.3):

a. Unlisted Components - (a) Components not listed in Table 326.1, but which conform to a published specification or standard, may be used within the following limitations.

[23] ASME B31.3 has specific requirements for variables, "L" and "S" as defined in Section VIII, Div 1.
[24] In case venting is required in an emergency
[25] See ASME B31.3, para 302.2.3. Listed components can be found in Table 326.1.
[26] Variance VAR-2010-001.0 evaluated Swagelok (including the old brands of Whitey, Cajon, and Nupro) to ASME B31.3 304.7.2 requirements

1) The designer shall be satisfied that composition, mechanical properties, method of manufacture, and quality control are comparable to the corresponding characteristics of listed components.

2) Pressure design shall be verified in accordance with para. 304:

304 PRESSURE DESIGN OF COMPONENTS

304.1 Straight Pipe

304.2 Curved and Mitered Segments of Pipe

304.3 Branch Connections

304.4 Closures

304.5 Pressure Design of Flanges and Blanks

304.6 Reducers

304.7 Pressure Design of Other Components

NOTE: Items that are not evaluated per 304.1, 304.2, 304.3, 304.4, 304.5, or 304.6 MUST BE evaluated by 304.7.

3) Other unlisted components shall be qualified for pressure design as required by para. 304.7.2.

4) Components built at LANL

a. Require qualification by engineering calculation to support pressure design consistent with the applicable code. Documentation showing compliance with the design criteria of the code approved by the owner shall be by one of the following:

i. Extensive successful service under the same loading and service conditions

ii. Experimental stress analysis[27]

iii. Proof test (e.g., Sect VIII UG-101 would be 4 times MAWP)

iv. Detailed stress analysis (such as finite element method)[28]

4. Documentation of acceptability must be by calculation. *A form is also available to assist in evaluating unlisted components.*

5. Unlisted components allowed for new construction must demonstrate equal or greater level of safety at the pressure and temperature of the system. *For example, an unlisted component rated at 16000 psig at 500 °F used in a system with a design pressure of 4,000 psig at 300 °F would have a factor of safety of 4:1. ASME B31.3 requires a factor of safety of 3:1. ASME B31.1 requires a safety factor of 4:1. This factor of safety would*

[27] See ASME Section VIII, Division 2, Annex 5.F.
[28] See evaluation as described in ASME Section VIII, Division 2, Part 5.

be acceptable for use either a B31.3 or B31.1 system. This same analysis may be used to evaluate existing system components.

6. Other criteria may be employed to evaluate pressure systems if:
   a. The pressure system is not subject to low-cycle fatigue (where significant plastic straining occurs)
      1) High-cycle fatigue (where stresses and strains are largely confined to the elastic region) is controlled to less than 100,000 cycles for the life of the pressure system.
      2) Corrosion is not a significant factor.
      3) There are no stress intensification factors for example cracks or acute angles or pressure boundaries
      4) The system components have exhibited extensive, successful service experience under comparable conditions with similarly proportioned
      5) If all the criteria above are met then the unlisted component used in an existing pressure system may be qualified as follows:
         a. Information provided by a reputable organization may be used to establish the MAWP of the unlisted item.
         b. The system shall be subjected to an initial service leak test per ASME B31.3 Initial Service Leak Test.
7. Information or testing results required may be documented in multiple formats, but must be referenced and readily available for review. This information shall be considered a record and be managed per LANL P1020, P1020-1, and P1020-2.

AA. Welding Systems

1. Welding systems meeting the criteria of OSHA 1910.253 *Welding, Cutting, and Brazing, Oxygen-fuel Gas Welding and Cutting* shall be designed in accordance with ASME B31.3 Process Piping.

BB. 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)
2. List of welding materials, to include filler materials
3. Heat treatment requirements
4. Method of welding, brazing or soldering (e.g., GTAW, SMAW, oxyacetylene, etc.)
5. Cleaning methods
6. Contain engineering design calculations or other approved ASME method that establishes the structural integrity of the design.

7. Specify the method(s) to examine the weld as defined by the appropriate ASME code (e.g., Section VIII Div 1 or B31.3)
8. Specify the pass/fail criteria to apply to the method(s) used to examine the weld.
9. Detail joint geometry, weld type, size, material type, and specification.
10. Utilize welding symbols in accordance with AWS A2.4 "Standard Symbols for Welding, Brazing, and Nondestructive Examination.
11. See also ESM Chapter 13 Welding Fabrication Procedure WFP 2-01, ASME B31 Series Piping Codes.

2.0 Computer Records

A. General

1. Facility systems must be included in the CMMS database for repetitive (preventive) and corrective maintenance.
2. Programmatic systems may elect to use either the CMMS database (*like LANSCE has*) or the PSCS database for repetitive maintenance.
3. All pressure safety unique files will be maintained in the PSCS database.

B. CMMS Database

1. The addition of a pressure vessel, removal of a pressure relief device, replacement of a pressure relief device and inspection of flex hoses shall be entered into CMMS for facility pressure systems.
2. Items that are not an exact replacement or engineered equivalent shall be updated in CMMS for facility equipment or the data repository for programmatic systems.
3. The MEL shall be maintained in accordance with AP-341-404.

C. DMAPS

1. Vessel inspection data must be entered into the DMAPS Database program. *Contact the LANL NDE/vessel inspection team (AET-6, 7-7077 or admin 7-6273) for assistance.*
2. A copy of the vessel inspection report produced by DMAPS must be provided to the pressure vessel owner, CPSO or designee
3. Vessel inspection reports must be maintained in the pressure system documentation package.
4. The DMAPS report will reference the TA-Bldg-Room (if applicable) and the system type so that it may be coordinated with the pressure system identification tag number.

D. Pressure Safety Certification Storage (PSCS)

1. PSOs may access the PSCS
2. Requires proof of UCNI training and crypto card.
3. Access is sponsored by CPSO or designee.
4. All walk down information is located on the PSCS database

5. PSCS is equipped with statistics for example to show number of systems certified, pending certification, in-active, exempt, and excluded by fluid service and FOD.

6. The PSCS is designed to allow electronic files to be attached to the system. In this way it may accommodate alternative formats that have the correct information.

7. FM03 and FM04 non-hardware issues observed by the original walk down teams reside in the PSCS. The Owner, PSO, and CPSO will review these findings and based on the requirements of ESM Chapter 17 determine which if any of the items must be completed prior to certification.

8. An FM02 is required for all relief devices and vessels that have a mandatory recall period.

ATTACHMENTS

Attachment ADMIN-2-1, Relief Device Selection Process for Gas Bottle Systems (Guidance)

Los Alamos NATIONAL LABORATORY EST. 1943

Conduct of Engineering
Request for Variance or Alternate Method

Assigned by SMPO or SMPOR: ☒ Alternate Method ☐ Variance Tracking number **VAR- 2015-032.0**

1.0 Affected Document(s)

☐ Engineering Processes (e.g., P 341) ☒ Engineering Standards (e.g., P 342) ☐ Engineering Training & Qualification (e.g., P 343) If against P documents themselves, revision:	Subordinate (Functional Series) document if applicable (ESM Chapter, Master Spec, AP, etc.): Document Title/Number: Engineering Standards Manual STD-342-100, Chapter 17, Pressure Safety Revision 0, 9/17/2014

Section/Para: Specified below

Specific Requirement(s) as Written in the Document(s)

1.1 This form was submitted in accordance with ESM Chapter 17, *Pressure Safety,* Section GEN, Paragraph E

1. Request for variance from compliance with this chapter, or alternate methods and clarifications, must be submitted to the CPSO, for review and approval processing.
2. Approval of an alternate method or variance can occur under the following circumstances:
   b. To permit a long-term operation with a condition that deviates from this document.
3. Approval is requested per ESM Chapter 1 Section Z10. (*Owner submits a Conduct of Engineering Request for Variance or Alternate Method, LANL Form 2137)*
4. The alternate method or variance (with duration, if applicable) must be approved by the CPSO and the Site Chief Engineer.
5. Approval of an alternate method must be based on establishing a level of worker safety consistent with the requirements of 10 CFR 851.

1.2 ESM Chapter 17, Section ADMIN-2 Design, Documentation, and Records, Section Q *Piping Components,* item 2:

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.

   a. Records of acceptable components and evaluations shall be kept by the CPSO and made available to all LANL employees.

1.3 ASME B 31.3,

300(c)(3) General Statements:

"(3) Engineering requirements of this Code, while considered necessary and adequate for safe design, generally employ a simplified approach to the subject. A designer capable of applying a more rigorous analysis shall have the latitude to do so; however, the approach must be documented in the engineering design and its validity accepted by the owner. The approach used shall provide details of design, construction, examination, inspection, and testing for the design conditions of para. 301, with calculations consistent with the design criteria of this code."

1.4 ASME B 31.3,

301.2.1 Design Pressure, General:

"(a) The design pressure of each component in a piping system shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service, except as provided in para. 302.2.4."

1.5 ASME B 31.3,

304.7.2 Pressure Design of Other Components, Unlisted Components

"Pressure design of unlisted components to which the rules elsewhere in para. 304 do not apply shall be based on calculations consistent with the design criteria of this Code. These calculations shall be substantiated by one or more of the means stated in paras. 304.7.2(a), (b), (c), and (d), considering applicable dynamic, thermal, and cyclic effects in paras. 301.4 through 301.10, as well as thermal shock. Calculations and documentation showing compliance with paras. 304.7.2(a), (b), (c), or (d), and (e) shall be available for the owner's approval.

(a) Extensive successful service experience under comparable conditions with similarly proportioned components of the same or like material.
(b) Experimental stress analysis, such as described in the BPV Code, Section VIII, Division 2, Annex 5.F.
(c) Proof test in accordance with either ASME B16.9, MSS SP-97, or Section VIII, Division 1, UG-101.
(d) Detailed stress analysis (e.g., finite element method) with results evaluated as described in Section VIII, Division 2, Part 5. The basic allowable stress from Table A-1 shall be used in place of the allowable stress, S, in Division 2 where applicable. At design temperatures in the creep range, additional considerations beyond the scope of Division 2 may be necessary.
(e) For any of the above, the designer may interpolate between sizes, wall thicknesses, and pressure classes, and may determine analogies among related materials."

2.0 Request

Brief descriptive title: Approval for use of Conflat (CF) flanged fittings in pressure systems under certain applications and conditions based upon analysis, testing, and successful service experience.	
NCR required (work has occurred)? ☐ Yes ☒ No	If Yes, NCR Number
TA-BLDG-(Room) and/or Project Affected: Lab-wide	System/Component Affected: New and modified pressure systems as applicable

Background

Applications exist at LANL where piping systems are required to be operated under both vacuum and pressure. Upon extensive research, it has been determined that there are not any reputable manufacturers who can provide components that are rated for vacuum service, and are either ASME B31.3 listed or have a published maximum allowable working (positive) pressure.

Proposal

This Alternate Method is being submitted for approval to use Conflat (CF) flanged fittings as unlisted components in new and modified pressure / vacuum systems under the following applications / conditions based upon analysis, testing, and successful service:

1. Applies only to 1-1/3" and 2-3/4" (outside diameter) stainless steel, rotatable and non-rotatable Conflat flanged fittings with copper gaskets.
2. Applies only to systems that require operation both under vacuum and pressure conditions where listed fittings from a reputable manufacturer that have a published MAWP and are rated for vacuum cannot be obtained.
3. The system design pressure / maximum allowable working pressure will be 50 psig for both 1-1/3" and 2-3/4" fittings.
4. Applies only to applications that are non-cyclic and which are operated within the temperature range of 60-120F.
5. Applies only to applications without dynamic loads, and when the piping system is supported at intervals specified in LANL Engineering Standards or MSS standards.
6. Applies only to fittings which are procured with 1-1/3" and 2-3/4" Conflat flanges attached (i.e. elbows, tees, adapters) and/or to Conflat flange stainless steel weld fittings which are attached to fittings.
7. This alternate method does not apply to valves procured with Conflat flanges. There are other features on valves (i.e. bellows, packing) that are not associated with the Conflat flanged connection that must be analyzed separately. (Refer to alternate method VAR-2013-086.0, *Alternate Method for Continued Operation of TWTS Inlet Header with the Current Installed Valves and Conflat (CF) Flanges)*
8. Conflat fittings must be made with high-tensile strength nut/bolt fastener combinations with torque values of 7 ft-lb for 1-1/3" fittings and 12 ft-lb for 2-3/4" fittings. Regular nuts and bolts are not suitable for CF flange applications. Bolts/nut materials, gaskets, and fitting make-up must be in accordance with Conflat fitting manufacturer specifications and requirements.
(Reference http://www.lesker.com/newweb/flanges/flanges_technicalnotes_conflat_1.cfm)

The evaluations presented in this Alternate Method include a combination of analyses, pressure tests and demonstrated successful service that meet the intent of ASME B31.3 300(c)(3) and 304.7.2.

This request is related to, and includes common reference documents to alternate method VAR-2013-086, *Alternate Method for Continued Operation of TWTS Inlet Header with Current installed Valves and Conflat Flanges.* VAR-2013-086 applies only to specific valves with Conflat fittings at WETF under the conditions stated in the alternate method.

Justification/Compensatory Measures:

1. A finite element stress analysis *Analysis of Conflat Flange Sets Subjected to Internal Pressures* per ASME Section VIII, Division I, Appendix 2 concluded that 2-3/4" OD 304 SS Conflat flanges with copper gaskets can withstand an internal pressure of 285 psig at room temperature. (Attachment 1)
2. A test report Indiana University *Leak Testing of Conflat-type Flanges Under Internal Pressure* concluded that 2-3/4" and 1-1/3" OD 304 SS Conflat flanges with copper gaskets pressurized to approximately 200 psig yielded no significant leak rated after cold cycling (2-6 cycles) between room temperature and <100K. (Attachment 2)
3. LANL W-7 test report *Proof and Leak Test of WETF Sensor Chamber Dwg 104Y-234083-14* (Attachment 3) documents that 2-3/4" OD Conflat (CF) flanges that were part of the WETF Sensor Chamber were pressure and leak tested on October 9, 2009 to a pressure of 250 psia (238.8 psig) for 8 minutes. The pressure in the WETF Sensor Chamber was then reduced to 225 psia and helium leak tested. The observed leak rate was less than 1x10-3 std cc/sec.
4. A piping header section in the WETF Tritium Waste Treatment System with 2-3/4" Conflat flanged fittings connected to Varian vacuum valves models L6591-301 and L8679-301 was pressure tested to 75 psig with a leak rate of less than 1x10-3 std cc/sec per WETF record WETF-02-687-R0, *TWTS Header RE-Route* (Attachment 4).
5. Vacuum valves models L6591-301 and L8679-301 with 2-3/4" Conflat flange connections were independently pressure and leak tested to 93 psia and 102 psia respectively with a leak rate of less than 1x10-3 std cc/sec. (Attachment 5, Group WX-5 Helium Leak Test Reports dated June 6th, 1986). It is noted that these specific two valves are approved for use in Alternate Method *VAR-2013-086, Alternate Method for continued operation of TWTS inlet header with the current installed valves and Conflat fittings* and are not the subject of this variance. These valves are referenced in this alternate method because of the pressure tests performed on these valves with Confat fittings. Valve model L6591-301 is HV-3-W in the WETF MEL and on drawing WETF-DR-TWTS-073.C and valve model L8679-301 is HV-2-W in the WETF MEL and on drawing WETF-DR-TWTS-073.C.
6. A Nupro 24VFBG valve with 2-3/4" Conflat flange connections pressure tested to 76 psig and leak-rate tested at 51 psig with a leak rate of less than 1x10-3 std cc/sec. (Attachment 6, W-7-AD-003U, Issue A, *GTS Proof and Leak Test Data Sheet*, dated 5/6/13.
7. Original Construction Specification for WETF (Attachment 7, *WETF Building Specification, TA-16, Bldg 205*) specified ½" and 1" stainless steel tubing with Conflat flange connections that were to have a design pressure of 50 psig and a test pressure of 75 psig. Although the original pressure test reports cannot be located and are presumed to be lost, WETF Tritium Waste Treatment System piping sections have been in extensive successful service with 2-3/4" and 1-1/3" Conflat flange connections in dual vacuum and pressure service up to 50 psig since 1986 with no record of failures or leakage.

Attachment 1: LANL report *Analysis of Conflat Flange Sets Subjected to Internal Pressures*, John C Ramsey, May 2010

Attachment 2: *Leak Testing of Conflat-type Flanges Under Internal Pressure, Indiana University,* October 2004

Attachment 3: LANL W-7 test report *Proof and Leak Test of WETF Sensor Chamber Dwg 104Y-234083-14,* 10/9/09

Attachment 4: Record WETF-02-687-R0, *TWTS Header RE-Route,* 9/4/02

Attachment 5: Group WX-5 Helium Leak Test Reports dated June 6th, 1986, (2 sheets)

Attachment 6: W-7-AD-003U, Issue A, *GTS Proof and Leak Test Data Sheet*, dated 5/6/13)

Attachment 7: *WETF Building Specification, TA-16, Bldg 205* (pertinent excerpt pages only attached)

Attachment 8: Conflat Information

Duration of Request:	Start Date:			End Date:	☒ Lifetime
Requestor Ed Hyde		Z Number 092739	Organization ES-WFO	Signature Signature on file	Date 6/18/15
USQD/USID required (Nucl. High/Mod Hazard)? ☐ Yes ☒ No			If Yes, USQD/USID Number		
Design Authority Representative Robert Swickley, ES-WFO		Z Number 228406	Organization ES-WFO	Signature Signature on file	Date 6/22/15
LANL Owning Manager (FOD or Programmatic) Brian Watkins		Z Number 206831	Organization WFO-FOD	Signature Signature on file	Date 6/25/15

3.0 Safety Management Program Owner (SMPO) Representative (SMPOR/POC)

☐ Decline ☐ Accept ☒ Accept Labwide ☒ with Modification: added web page info.			
POC Ari Swartz	Z Number 235211	Signature Signature on file	Date 6/29/15

4.0 Additional Approval for P341 and APs; P342, ESM, Code, and Regulation Matters; and P343

☒ Accepted ☐ Accepted with comments ☐ Declined			
Comments:			
Safety or Security Management Program Owner Lawrence Goen	Z Number 106351	Signature Signature on file	Date 6/29/15

Relief Device Selection Process for Gas Bottle Systems (Guidance)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Was Appendix D of Section I, rev. 3	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

This document provides a sample calculation to illustrate the methodology to be used to size a relief device for a gas bottle system.[1]

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

> Note: Both cases involve the placement of the orifice upstream of the regulator. The orifice may be placed downstream of the regulator, but different calculations must be performed.

The following design parameters are assumed for this pressure system:

Gas Bottle: Nitrogen at 2265 psig

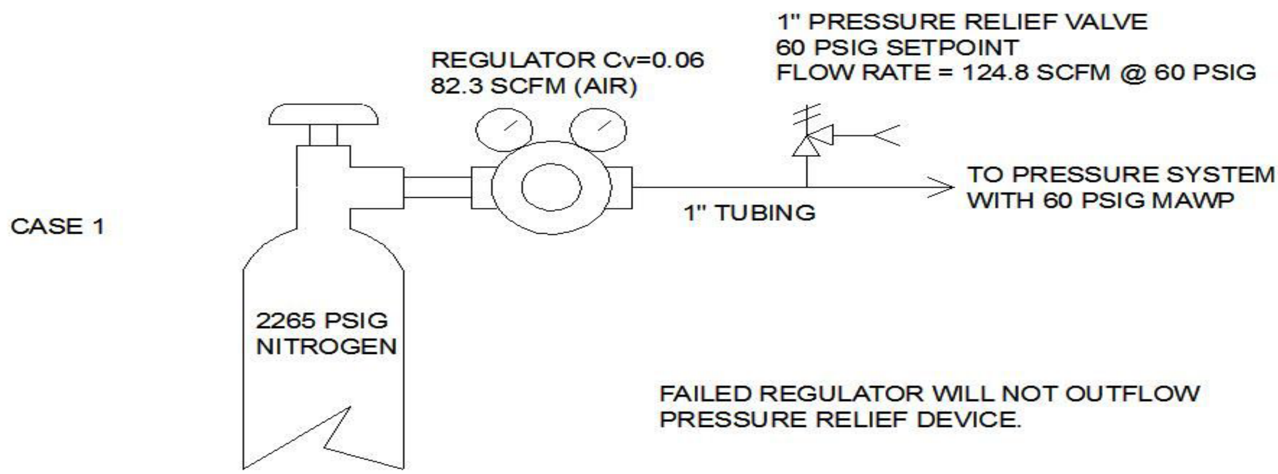
Regulator: Scott model 51-3300E-CGA, with a C_v = 0.06

Regulator downstream MAWP = 60 psig

Relief valve set pressure = 60 psig

[1] This sample calculation uses information contained in ARES calculation 0633301.52-M-062 (LANL CALC-10-00-786-PSS-GEN-00001r0), which is available as “Compressed Gas System Flow Calculation (pdf)“ via the Pressure Protection Program Website: http://int.lanl.gov/org/padops/adnhho/engineering-services/pressure-protection-program/index.shtml

CASE 1



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

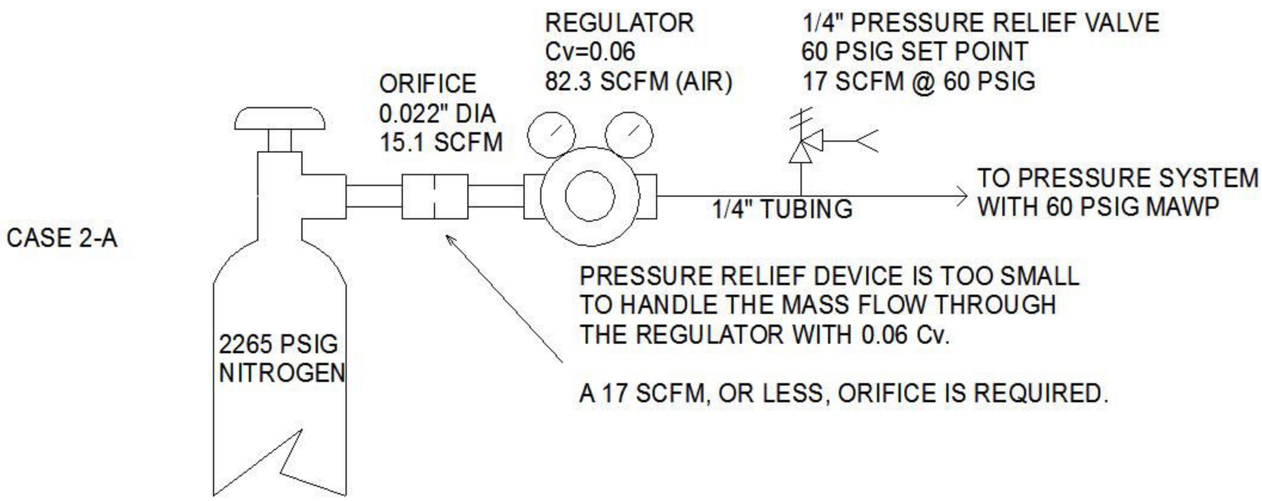
For valve selection, refer to the capacity data for Kunkle Relief Models 264 through 267 (ASME Section VIII, Air/Gas and Steam, National Board Certified). Valve inlet sizes: ½", ¾", 1". Refer to Kunkle catalog at: http://www.kunklevalve.com/catalog/_264.pdf

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



Case 2-A

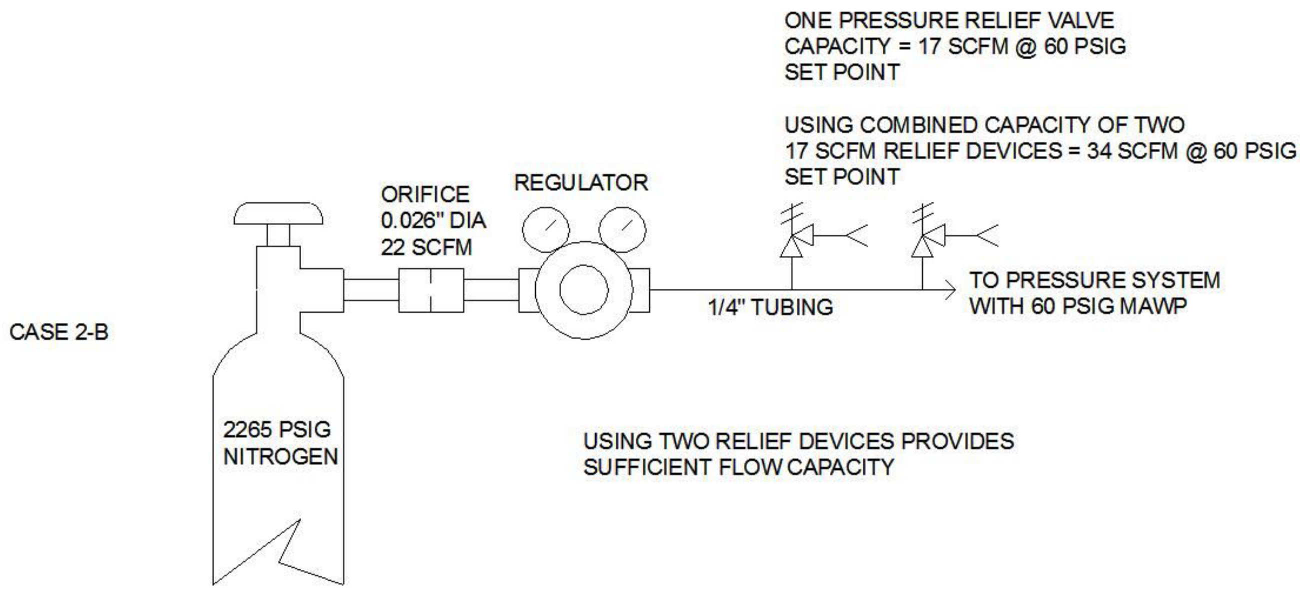
Regulator downstream pipe size: ¼ inch

82.3 scfm is too much 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.circlesealcontrols.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 0.022 inch, the orifice flow of 15.1 scfm is within the relief valve capacity of 17 scfm.

CASE 2-B



<u>Case 2-B</u>

Regulator downstream pipe size: ¼ 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.

Table of Contents

A. General....2
B. Procurement Review (ASM Form 410)....3
C. Fabrication of New System....3
D. Rupture Disk Procurement....4
E. Relief Valve Pre-Testing....4
F. Rental Pressure Systems....4
G. ASME Code-Stamped Boilers and Vessels....4
H. Non-Code Vessels....4
I. Flexible Hoses and Flexible Tubing Procurement....5
J. Tagging and Labeling....5
K. Welding, Brazing, and Soldering....5
L. Piping and Tubing....6
M. Cleaning....6
N. Alignment....6
O. Flanged joint assemblies:....7
P. Threaded Joints....7
Q. Tubing Joints....7
R. Oxygen and Oxidizing media components cleanliness requirements....7
FORMS....9
Form ADMIN-3-FM01, Relief Device Procurement Pre-approval....9

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue. Revision of material formerly in Section I	Ari Ben Swartz,	Larry Goen,

		Rev. 3 Article 12.0.	*ES-EPD*	*ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Procurement, Fabrication, and Assembly

A. General

1. 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.
   a. 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. In addition to meeting and citing all other applicable procurement requirements in this document, procured pressure systems and components must shall the following where applicable, and documentation must be received with documentation from the manufacturer (ideally) or supplier 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.
   f. Purchased systems and custom systems must be built to the most applicable ASME code

B. Procurement Review (ASM Form 410)[1]

1. If the CSPO or designee determines that his/her review of proposed procurements is necessary to ensure that requestors/TSMEs are aware of and properly execute this chapter's requirements, then LANL ASM Form 3041.00.0410 "Goods or Services Requiring Internal Review & Approval" shall contain such requirements at CPSO discretion.

2. Requestors of relief devices will normally be expected to provide all the information in attached Form ADMIN-3-FM01, Relief Device Procurement Pre-approval. *For relief devices, the CPSO review should check such things as:*

   a. the pressure system is in the database

   b. the relief device flow is greater than the regulator flow,

   c. the relief inlet size is equal to or larger than the connection to the system,

   d. the set pressure is less than or equal to the system MAWP, and

   e. bench stock relief devices are purchased as ASME-stamped valves.

3. For pressure vessel procurements, purchase must require (a) NBIC numbering and registration and (b) manufacturer's data reports (see Section ADMIN-2 for other pressure vessel requirements).

C. Fabrication of New System

1. Appendix M contains the Pressure System Owner Checklist to assist the System Owner, PSO, Owner's Inspector, and Examiner fabricate a new system and identify the required inspections and evaluations.

2. Special requirement exist to use thermoplastics with flammable materials, see ASME B31.3 A323.4.2(a)(1).

3. PVC or CPVC shall not be used in compressed air or other compressed gas services, see ASME B31.3 A323.4.2(a)(3).

---

[1] Procurement review was successfully used at SRS for decades to ensure that new systems meet pressure safety program requirements, and maintenance of existing systems maintains configuration control of certified systems. Form 410 (3041.00.0410) can be found at https://asmdocs.lanl.gov/docs/Forms%20%20General/Forms/AllItems.aspx, directly here. Rev 18, 6/20/14, stated: Pressure Vessels & Systems:
- Power Boilers
- Heating Boilers
- Commercial Water Heaters
- ASME Section VIII Stamped pressure vessels
- Non-ASME-code-stamped pressure vessels
- Manufactured pressure systems other than ASME code stamped boilers and heaters
- Leased LANL-operated air compressors with tanks greater than 6 inches in diameter
- DOT vessels intended for permanent installation in a pressure system
- Relief Devices: safety relief valves, relief valves, and rupture discs

D. Rupture Disk Procurement

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

E. 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[2]. Such testing is not required if:[3]
   a. PRV setpoint adjustment is sealed by supplier and seal is unbroken, or tamper-proof and supplier meets the code of construction requirements.
   b. The supplier is on the LANL qualified suppliers list (IESL, internal: here)[4] or approved by the CPSO.
      1) Guidance: CPSO approval listing is posted at ES-Division Pressure Protection Program homepage (internal here).
   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.

F. 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.[5] Documentation must be made available upon request.
2. Rental pressure systems must be verified maintained by the owner.

G. ASME Code-Stamped Boilers and Vessels

1. See Section ASME of this chapter.
2. Controls, safety devices, and gas train shall comply with CSD-1 *Controls and Safety Devices for Automatically Fired Boilers*.
3. Boilers with fuel input rating greater than or equal to 12,500,000 Btu/hr fall within the scope of NFPA 85, *Boiler and Combustion Systems Hazard Code*.

H. Non-Code Vessels

1. Procurements of non-code stamped vessels must be reviewed by CPSO.[6]
   a. Vessel MAWP and over pressure protection is sufficient to achieve code equivalent protection from over pressurization.
   b. Design, and inspection documentation is readily available (weld inspection, pressure tests, etc.).

---

[2] This requirement became effective Sept 2010
[3] Contact MSS division for relief device testing capabilities. API recommended practice; experience of need at NASA, SRS, Y-12; and commercial nuclear practice.
[4] If the supplier is on the IESL, they have a quality pedigree for ML-1/2 nuclear safety and are therefore a trusted supplier; however, any PRV used for nuclear safety may warrant verification of setpoint and other attributes nevertheless.
[5] Captured by LANL ASM Form 410 (3041.00.0410) Goods and Services Requiring Internal Review and Approval, also see this topic higher in this Section.
[6] Ibid.

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.

I. 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.

J. Tagging and Labeling

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

K. 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.

L. 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.

M. 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.

N. Alignment

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.
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.

O. Flanged joint assemblies:[7]

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.[8]
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.[9]

P. 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.

Q. 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.

R. Oxygen and Oxidizing media components cleanliness requirements10

1. General requirement
    a. This section is applicable to both liquid oxygen (LOX) and gaseous oxygen (GOX) systems and other similar oxidizing agents (e.g. N_2O_4, HNO_3, etc.)
    b. Oxygen systems shall be designed (including materials selection), tested, cleaned, and assembled in accordance with ASTM G128 and other referenced ASTM standards. The design, testing, cleaning, and assembly shall be documented as an oxygen hazards analysis and shall be approved by the CPSO. The system shall be evaluated to reduce the likely hood of fire.
    c. If no oxygen hazards analysis is performed then components installed into oxygen or oxidizer fluid systems must be cleaned to a level equal to or better

[7] Ibid.
[8] Accommodate material relaxation. Industry good practice.
[9] LANL ASME B31.3 Process Piping Guide ESM Chapter 17 Section REF-3
[10] ASTM G 93

than 175A as defined in ASTM G93 para. 11.4.3, where the nonvolatile residue remaining after cleaning is less than 1 mg/ft^2, 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.*

d. *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.*

e. *Any method of cleaning may be utilized provided that cleaning method meets, or exceeds the requirements as defined in ASTM G93 for level 175A.*[11] *Components may be cleaned by the manufacturer.*

f. Components must be maintained clean during the assembly/construction process.

g. Oxygen-compatible lubricants should be applied after component cleaning

h. 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.

i. Components cleaned for oxygen service must be handled with clean gloves or handling devices to maintain oil-free cleanliness of component.

2. If no oxygen hazards analysis is performed, then the following cleaning procedures are required:

a. The cleaning method used must incorporate three cleaning steps as defined in ASTM G93 as follows:

1) Precleaning – removal of gross contaminants

[11] Refer to ASTM A 380 which describes cleaning, descaling, and passivation of stainless steel parts, equipment and systems.

2) Intermediate cleaning – use of alkaline salts, detergents, acids, or caustics to remove solvent residues and residual contaminants.

3) 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. If no oxygen hazards analysis is prepared the following packaging is required:

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. If no oxygen hazards analysis is prepared the following assembly is required:

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[12].

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.

FORMS

Form ADMIN-3-FM01, Relief Device Procurement Pre-approval

[12] ASTM G93

ADMIN-3-FM01 Relief Device Procurement Pre-approval

Form must be signed and approved by a Certified DCPSO in order to procure (per ASM Form 410).
(data for example only, delete when using form)

PSS #	TA	Bldg	Valve	Regulator / RFO	Max Flow	Relief Device	Set Press.	System MAWP	Relief Flow	Relief Inlet	Sys. Conn.
Tag #			Valve tag # off of P&ID	Model # of Regulator or RFO	SCFM of air Or BTUH/GPM	Make & Model #			Flow in SCFM, BTUH, or GPM	Pipe Size	Pipe Size
5933	53	4	PCV1	Norgren R72G-3AK-NCG	0.76	0542-A01-KM0035	35 psig	35 psig	53.2	1/4"	½”
			RFO 0.030"	Swagelok SS-4-A-08179-SC11	Approx. 21 SCFM @ 2265 psig						
5940	53	4	PCV1	Norgren R72G-3AK-NCG	0.76	0542-A01-KM0035	35 psig	35 psig	53.2	1/4"	1/4"
			RFO 0.030"	Swagelok SS-4-A-08179-SC11	Approx. 21 SCFM @ 2265 psig						
2201	53	4	None	None	Compressor 2 stage 250 psig; 150 scfm	Kunkle (part number omitted in this example)	250 psig	250 psig	175	1/2”	3/4”
2011	53	1	None	None	Boiler rating 230,000 BTU/Hr	Kunkle (part number omitted in this example)	250 psig	250 psig	300,000	1/2”	1/2”

DCPSO: ______________________________ Z #: ___________ Signature: ___________________________________ Date: ________________

Table of Contents

1.0 INSPECTION AND TESTING ... 2
A. Inspection/Examination ... 2
B. Testing ... 3
2.0 INSPECTION AND TESTING INTERVALS ... 5
A. Vessel Inspections ... 5
B. Relief Devices ... 7
C. Flex hoses ... 11
D. Pressure Regulators ... 11
3.0 DOT, IM, AND UM PORTABLE TANKS ... 11
A. General Information ... 11
B. Special Instructions for DOT-4L Cylinders ... 11
C. Inspection Frequencies ... 12
4.0 MOBILE PRESSURE SYSTEMS AND TRANSPORT TANKS ... 13
A. Definitions ... 13
B. Procurement ... 14
C. Pressure Relief Devices ... 14
D. Piping, Valves, and Fittings ... 15
E. Pressure System Documentation Package ... 15
F. Repairs and Alterations ... 15
G. Tests and Inspections ... 15
5.0 ATTACHMENTS ... 16
ADMIN-4-1 Pressure Vessel Inspection and Test Procedure ... 16
ADMIN-4-2 Hose Assembly Inspection Guidance ... 16
ADMIN-4-3 Pressure Regulator Maintenance Guidance ... 16

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue; revision of material formerly in Section I, rev. 3.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**[Pressure Safety POC and Committee]**

This document is online at http://engstandards.lanl.gov

1.0 Inspection and Testing

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.[1]

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.
   a. The manufacturer, fabricator or builder must perform examinations as required by the design documents and applicable code.
   b. The fabrication, repair, or alteration documentation must have evidence of the examination; evidence must be maintained in the pressure system documentation package.
   c. 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.
   d. The Initial Service Leak Test specified in ASME B31.3 para. 345.7 may be applied for ASME B31.3 Category D fluids in low volume piping systems built from rigid tubing and listed tubing fittings or CPSO-approved alternative fittings with non-welded connections.

[1] 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.[2]

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 by the code of record. *For existing systems, LANL Master Spec Section 22 0813 may need to be adapted for this purpose.*
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.
    g. Hydrostatic tests must be performed with water. If water is not suitable (could freeze, or cause adverse effects 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 by the manufacturer or LANL Calibration Lab.
    i. The pressure of the qualification test must be maintained for at least 10 minutes.
    j. Test procedures and results must be maintained in the system documentation package.
4. A modified initial service leak test of LANL legacy systems is allowed.
    a. The initial service leak test shall be conducted at normal system operational pressure.

[2] 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

b. The entire system shall be inspected for leak tightness at the normal system operational pressure. However, it is not required for portions of the system that are inaccessible to be inspected. Removal of external insulation is not required. Evidence of leakage in the insulation shall be cause for failure.

c. The leak test shall be for a minimum of 10 minutes.

d. Leak testing shall not be performed when metal temperatures are near the ductile-brittle transition temperature, as that may lead to brittle fracture.

e. Testing methods and results may be documented in multiple formats, but must be referenced and readily available for review. This information shall be considered a record and shall be included in the pressure system certification package.

5. The pneumatic or pneumatic hydrostatic leak test in accordance with ASME B31.3 para. 345.5 may be applied to LANL systems for all ASME B31.3 fluid services except High Pressure. Pressure testing may not be done with reactive gas, flammable gas, Category M fluids, or radioactive gas, but testing with an inert substitute gas is allowed. Test volume is limited to approximately 2 cubic feet of volume not including the gas supply system.[3]

6. Application of ASME B31.3 345.5.2 Pressure Relief Device "A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 345 kPa (50 psi) or 10% of the test pressure when design pressure is less than the piping component MAWP.

   a. The owner or owner's representative must have approved a pneumatic or hydrostatic-pneumatic test in accordance with B31.3.

   b. The pressure system supplying the test gas shall have adequate relief protection to ensure the piping component MAWP is not exceeded.

   c. If the first and second requirements above are satisfied then a relief device is not required if the test pressure is not above the MAWP of the piping components.

   Example: The tubing MAWP is 2199 psig. The pressure testing supply gas has an adequately supplied relief valve set at 200 psig. The design pressure is 100 psig. No additional relief protection is required.

7. Rad Liquid Waste: The Owner has elected to treat RLW as B31.3 Normal Fluid Service and testing must be done accordingly; paragraph 345.1 (a) is not applicable.

[3] VAR-2012-014.1

2.0 Inspection and Testing Intervals

All inspection and testing intervals shall be fixed. All inspection and test intervals are granted a grace period of 90 days for performance of the requirement.

A. Vessel Inspections

1. Use the following tables for determining the inspection intervals for pressure vessels, relief devices, and piping.[4]
2. Perform vessel inspections per ESM Chapter 17 ADMIN-4-1, Pressure Vessel Inspection and Test, using CPSO-approved organization *(e.g., AET-6).*
3. Boiler and pressure vessel inspection shall be based on NB-23 Boiler and Pressure Vessel Inspection Code and on the API 510 Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alternation (latest edition) as is shown in Section ADMIN-4-1, Pressure Vessel Inspection and Test Procedure.

Table ADMIN-4-1 Pressure Vessels Exempt from Mandatory Periodic Test/Inspection[5]

Vessels listed as exempt from the scope of ASME Section VIII, Division 1 – 2007 with 2009 addendum shown others are similar. Use most current version of ASME Section VIII, Division 1 for latest exempt vessel list.

U-1(c)(2) Based on the Committee's consideration, the following classes of vessels are not included in the scope of this Division; however, any pressure vessel which meets all the applicable requirements of this Division may be stamped with the Code U Symbol:

(a) those within the scope of other Sections;

(b) fired process tubular heaters;

(c) pressure containers which are integral parts or components of rotating or reciprocating mechanical devices, such as pumps, compressors, turbines, generators, engines, and hydraulic or pneumatic cylinders where the primary design considerations and/or stresses are derived from the functional requirements of the device;

(d) except as covered in U-1(f), structures whose primary function is the transport of fluids from one location to another within a system of which it is an integral part, that is,piping systems;

(e) piping components, such as pipe, flanges, bolting, gaskets, valves, expansion joints, fittings, and the pressure containing parts of other components, such as strainers and devices which serve such purposes as mixing, separating, snubbing, distributing, and metering or controlling flow, provided that pressure containing parts of such components are generally recognized as piping components or accessories;

(f) a vessel for containing water[6] under pressure, including those containing air the compression of which serves only as a cushion, when none of the following limitations are exceeded:

---

[4] Bases for frequencies documented in EM Ref-59. *(EMRef is a Standards Program system for maintaining references/bases)*

[5] 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.

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

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

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

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

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

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

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

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

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

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

(j) pressure vessels for human occupancy.[7]

Table ADMIN-4-2 Inspection Frequencies for Non-Exempt Pressure Vessels

Service	External + wall thickness (e.g, ultrasonic)	Internal
Corrosive	3	5
Non-corrosive	5[8]	10[9]

[6] 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

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

[8] 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.

[9] 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.

4. 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.[10]

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

   b. Annual internal inspection is required for high-pressure boilers and high pressure steam generators.

   c. Every 24 months an external and internal inspection must be performed on the following:

      1) Direct fire steam jacketed kettles

      2) Low-pressure steam boilers

      3) Low-pressure hot water heating boilers

B. Relief Devices

1. 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[11].

2. 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.[12]

3. 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.

---

[10] 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.

[11] See ASME PTC-25 for relief device testing requirements.

[12] See ASME Section VIII, Division 1, Part UG-131.

4. 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

        1) Due date of next test (as defined in this document)

5. *Guidance: LANL O&M Criterion and preventative maintenance procedures (PMIs) related to pressure relief devices are available at this internal link.*

    PMI 419-A, Pressure Relief Valve Testing

    a. *Criterion 403 "Boilers"*

        1) *PMI documents: 403-A: Low- and High-Pressure Steam Boiler and Low-Temperature Water Heating Boiler Inspection, Testing, and Maintenance; 403-A.001: Hot Water Boiler Startup After Lay-Up; 403-A.002: Hot Water Boilers Water Treatment; 403-A.003: Hot Water Boiler Weekly Preventive Maintenance; 403-A.004: Hot Water Boiler Weekly Log Sheet (Deleted - Do Not Use - Refer to 403.A.010); 403-A.005: Hot Water Boiler Monthly Preventive Maintenance (In Service Only); 403-A.006: Hot Water Boiler Annual Fireside/Waterside Inspection and Maintenance; 403-A.007: Steam Boiler Startup After Lay-Up; 403-A.008: Steam Boiler Water Corrosion and Scale Inhibitor Treatment; 403-A.009: Steam Boiler Weekly Preventive Maintenance; 403-A.010: Steam Boiler Weekly Log Sheet; 403-A.011: Steam Boiler Monthly Preventive Maintenance (In Service Only); 403-A.012: Steam Boiler Annual Waterside and Fireside Inspection and Maintenance (In Service Only); 403-A.013: Steam Boilers Summer Lay-Up; 403-A.014: Hot Water Boiler Summer Lay-Up*

    b. *Criterion 419 "Inspection and Testing of Pressure Vessels and Pressure Relief Valves"*

        1) *PMI documents: 419-A: Boiler Relief Valve Testing; 419-A.001: Pressure Relief Device Removal, Transport, and Reinstallation Checklist; 419-A.002: Test Summary Report Form; 419-55-0000-A: 55-0000 Specialty Gas Systems; 419-55-0000-A.001: 55-0000 Specialty Gas Systems - Annual*

6. 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

7. Table ADMIN-4-3 indicates pressure relief device test (set point verification) and replacement intervals.

Table ADMIN-4-3 Relief Device Maintenance Intervals

Fluid Service/Type (alphabetical for PRVs; rupture disks at bottom)	Test Frequency (Years)[13]	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 O_2)	5	Reuse or Replace	Test
Inert gas or non-corrosive liquids (including dry air kerosene, non-acidic oils, etc.)	5	Reuse or Replace	Test

[13] 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 PSO should initiate an appropriate change in the CMMS in conjunction with system owner/engineer.

Fluid Service/Type (alphabetical for PRVs; rupture disks at bottom)	Test Frequency (Years)[13]	Reuse or Replace Device	Reused Device Treatment
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
NOTES: ** If installation direction cannot be verified or the damage ratio is ≥ 1.0, disk must be replaced every 2 years. *Basis for table is EMRef-58 (EMRef is a Standards Program system for maintaining references/bases)*			

C. Flex hoses

1. Flex hoses shall be inspected for flaws during system reviews by the PSO, and those found unacceptable shall be removed from service.
2. The inspection and acceptance evaluation process shall be based on the manufacturer's requirements and the PSO subjective evaluation of the flex hose to safely perform its function. See Section ASME (*Attachment ASME-4-2).*
3. *Flex hose inspection guidance is provided in Attachment ADMIN-4-2, Hose Assembly Inspection Guidance.*

D. Pressure Regulators

1. Attachment ADMIN-4-3 contains pressure regulator maintenance guidance.

3.0 DOT, IM, and UM Portable Tanks

A. General Information[14]

1. Refilling of an expired DOT portable vessel is prohibited
2. 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.
3. 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.

B. Special Instructions for DOT-4L Cylinders[15]

WARNING: A cylinder used for CO_2 service must remain CO_2 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
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_2) must be re-liquefied per the manufacturer's instructions.

---

[14] Chart Industries, Inc., "Liquid Cylinder" Users Manual P/N 10642912 Date:12/00
[15] Ibid

C. 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 or mobile pressure systems must be retested per 49 CFR or ASME Section XII.
4. 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 ADMIN-4-4 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.		

5. The following table defines the NBIC inspection frequencies for DOT, IM, and UM portable tanks and vessels. Portable vessels must be maintained within their inspection due dates.[16]

Table ADMIN-4-5 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.		

4.0 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.

[16] NBIC Part-2 Table S6.14, Inspection Intervals

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.
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 (*AssetSuite, formerly "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.
5. When all components of a pressure system have a design pressure equal to or greater than the system pressure, there is no requirement for a pressure relief device. Consequently, there is no requirement for pressure relief documentation, calculations, maintenance of the pressure relief device, or inclusion of the relieve device into CMMS or the PSCS database as a maintenance item.
6. PRVs during leak testing: Application of the required relief device in accordance with ASME B31.3 345.5.2 should be done as follows:

   First the owner or owner's representative must have approved a pneumatic or hydrostatic-pneumatic leak test in accordance with B31.3 345.1(b).

   Second, the pressure system supplying the test gas shall have adequate relief protection to ensure the piping component MAWP is not exceeded.

   If the first and second requirements above are satisfied, then a relief device is not required if the test pressure is not above the MAWP of the piping components.

   For example, if using TP304 ASTM A312 4 inch schedule 40 pipe, the nominal thickness is 0.237 inch with the B31.3 Appendix A value.

   t = PD/(2*(SEW+PY)) [304.1.2 equation 3a]

   rearranged:
   P = 2tSEW/(D-2Yt)

S = 20,000 psi

E = 1

W = 1

Y = 0.4

D = 4.5 (outside diameter)

T = 0.237 (nominal not subtracting the production tolerances)

P = 2*(0.237)*1*1*20,000/(4.5-2*0.4*0.237))

P = 2199.3 psig nominal

Assume an adequately sized relief device is installed to limit the pressure to less than 2199 psig + 10% or 2419 psig for the supply pressure for the leak test. So, if the system design pressure is 100 psig and the pneumatic leak test pressure is 110 psig, then because 110 psig << 2199.3 psig, no additional relief device is required.

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.

5.0 ATTACHMENTS

ADMIN-4-1 Pressure Vessel Inspection and Test Procedure

ADMIN-4-2 Hose Assembly Inspection Guidance

ADMIN-4-3 Pressure Regulator Maintenance Guidance

ADMIN-4-1 Pressure Vessel Inspection and Test Procedure

REQUIRED FOR WORKING COPIES ONLY

A working copy of this document is valid only until the document revision number has changed on the web. The paper copy should be dated and signed the day it is printed. If you continue working from the paper copy, you should re-verify its accuracy on the web after seven calendar days.

Date	Verified/Re-verified Signature/Initials

TABLE OF CONTENTS

1.0 PURPOSE 3
2.0 AUTHORITY AND APPLICABILITY 4
2.1 Authority .... **Error! Bookmark not defined.**
2.2 Applicability 4
3.0 PRECAUTIONS AND LIMITATIONS 4
4.0 PREREQUISITE ACTIONS 5
4.1 Planning and Coordination 5
4.2 Performance Documents 5
4.3 Special Tools, Test Equipment, Parts and Supplies 5
4.4 Approvals and Notifications 6
5.0 PERFORMANCE ACTIVITIES 6
5.1 Vessel Inspection Prior to Service 7
5.2 Site-Fabricated Vessel Inspection Prior to Service 7
5.3 External Inspection 7
5.4 Thickness Measurement 9
5.5 Internal Inspections, Preparing for 10
5.6 Internal Surface Inspection 10
5.7 Repairs and/or Alteration Inspection 12
5.8 Hydrostatic Testing 12
5.9 Pneumatic Testing 13
6.0 POST-PERFORMANCE ACTIVITIES 14
6.1 Results 14
7.0 RESPONSIBILITIES 15
8.0 IMPLEMENTATION 15
9.0 TRAINING 15
10.0 EXCEPTION OR VARIANCE 15
11.0 DOCUMENTS AND RECORDS 15
12.0 DEFINITIONS AND ACRONYMS 16
12.1 Definitions 16
12.2 Acronyms .... **Error! Bookmark not defined.**
13.0 HISTORY 16
14.0 REFERENCES 16
15.0 FORMS 16
16.0 CONTACT 16

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue as ADMIN-4-1. Previously in Chapter 17 as ITM-342-1701 r0, 8/3/2009. Minor admin updates.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

1.0 PURPOSE

This procedure provides instructions to establish a method for inspection and testing of pressure vessels in accordance with applicable drawings, specifications, codes, standards, and policies that fall within the scope of ESM Chapter 17 Pressure Safety, Section ADMIN-4, which sets maximum inspection intervals and defines excluded vessels. These inspection intervals may be adjusted downward by the fitness for service evaluation for any specific vessel based on the findings of the inspection.

Section I frequency requirements at time of writing:

Inspection Frequencies for Non-Exempt Pressure Vessels

Service	***External + wall thickness (e.g, ultrasonic)***	***Internal***
Corrosive	*3*	*3*
Non-corrosive	*5*	*10*

This procedure may be used for vessels and tanks rated below Chapter 17 pressure, size, and service limits.

Sections **5.1** through **5.9** of this procedure may be performed independently or omitted, as necessary.

2.0 APPLICABILITY

2.2 Applicability

This document applies to qualified pressure vessel inspection personnel performing inspections and tests at LANL.

3.0 PRECAUTIONS AND LIMITATIONS

A. Ground fault circuit interrupters (GFCIs) shall be used on all electrically-driven equipment (110 VAC only).

B. Barricades and/or flagging, if used, shall be installed in accordance with LANL policy.

C. Low-voltage safety lights and air-driven tools shall be used inside the vessel as required by the Job Hazard Analysis (JHA) or safety work permit.

D. Inspection and testing of pressure vessels shall be conducted by code-qualified inspectors (i.e., those who have passed the API or National Board of Boiler and Pressure Vessel Inspectors examination).

E. Discovery of a non-code stamped pressure vessel with request for continued use shall be reviewed/approved as safe for continued operation by the Chief Pressure Safety Officer (CPSO).

F. Pneumatic testing shall be limited to pressure vessels where testing with a liquid is impractical or when the equipment cannot be exposed to liquids and shall be approved by the CPSO.

G. Hydrostatic testing shall be performed when inspection discloses unusual, hard to evaluate forms of deterioration that may affect the safety of the vessel. Hydro testing also shall be performed as requested by Operations or Engineering or by the Inspector to confirm suspected leaks and following repairs or alterations.

I. Pressure vessel(s) shall be evaluated for any condition that may affect the remaining life of the vessel. The remaining life may be adjusted based on conditions such as corrosion, erosion in local areas, fatigue, creep, operating and ambient temperatures, effects of hydrogen attack and embrittlement, and stress-corrosion cracking.

J. The maximum period between internal inspections or a complete in-service evaluation of pressure-retaining items shall not exceed the inspection frequency per ESM Chapter 17 Section ADMIN-4.

K. Pressure vessels that have been out of service for one year or more and are past due on an inspection shall be inspected prior to being placed into service.

L. External ultrasonic thickness measurement may be performed in lieu of internal inspections if the internal inspection is impractical or presents excessive hazards to the Inspector. In such cases, the next ultrasonic measurement interval shall be determined the same as for the internal inspection interval described in Item **3.J**, above.

M. Each new, structurally repaired, or altered pressure vessel shall be inspected and tested before use.

N. Pressure vessels within the scope of the ASME Code shall be code stamped in accordance with the applicable section of the ASME code, unless a Code Equivalency determination is made in accordance with ESM Chapter 17 Section GEN.

O. Pressure vessels shall **NOT** have any leakage. Any evidence of leakage shall be thoroughly investigated prior to acceptance of the vessel.

P. Pressure vessels, appurtenances, associated piping and connections shall be rejected for abrasion, dents, distortion, cuts, gouges, or other significant defects that may affect the vessel integrity.

Q. Measurements of pressure vessel wall thickness shall **NOT** be less than the minimum allowable thickness identified by Engineering.

R. Where this procedure conflicts with LANL-adopted national code requirements, those codes shall take precedence.

S. Performance steps in Section **5**, *Performance Activities*, do **NOT** have to be performed in a step-by-step manner; however, all applicable steps within a topic shall be performed unless otherwise documented on the applicable DMAPS inspection report.

4.0 PREREQUISITE ACTIONS

4.1 Planning and Coordination

NDE Supervisor/Designee

[1] Obtain work authorization from the owner/user or operating organization. Inspections within nuclear facilities shall be scheduled on the Plan-of-the-Day.

[2] Conduct pre-job briefing(s) prior to pressure vessel inspection and testing that includes a pre-inspection review of applicable safety and operations documents, including the most current Job Hazard Analysis (JHA) and associated permits (including confined space entry permits for internal inspections), tagouts, special hazard controls or barriers, etc.

Inspector

[3] Obtain and review the inspection folder for the vessel to be inspected (*should be in the EDMS)*. This should contain the U-1 or U-1A data sheet from the manufacturer or NBIC. If not, coordinate with owner to purchase from NBIC.[1]

[4] Obtain current copies of the documents identified in Section **4.2**, *Performance Documents*, as necessary.

4.2 Performance Documents

- DMAPS pressure vessel inspection checklist and record of wall thickness measurements
- Section VIII, Div. 1, *ASME Boiler and Pressure Vessel Code*, latest edition
- NBIC ANSI/NB-23, *National Boiler Inspection Code*, latest edition.
- U1 or U1A report of vessel to be inspected (5.1).
- Service history and cycle history of vessel to be inspected. (5.1 [5])

4.3 Special Tools, Test Equipment, Parts and Supplies

- air-driven tools
- barricades and/or warning devices, as needed
- borescope

[1] Approx $20/per. Without data sheet, assumptions would need to be made that could require rerating of the vessel

- inspection mirrors
- calibrated pressure gauge
- calibrated thermometer (for hydrostatic and pneumatic testing)
- GFCIs (for electrical equipment)
- hydro test equipment
- low voltage safety lights
- non-sparking hammer
- ultrasonic thickness gauge
- wire brush
- oxygen meter (if required for vessel entry)

4.4 Approvals and Notifications

NDE Supervisor/Designee

[1] Obtain permission from the equipment owner, Building Manager/Shift Manager or designee to begin inspection, as appropriate.

[2] Obtain approval for discharging fluid from systems hydrostatically tested, as necessary. See also LANL Master Spec 01 3545, Water Discharge Requirements

NOTE *Where beryllium or radiological hazards may exist, the FOD IH Office or RADCON Office, respectively, will evaluate the hazard conditions(existing and anticipated) and specific work activities to make a BWP or RWP determination (none required, use existing, generate new).*

[3] **IF** any of the following beryllium conditions exist:

- Performing work in beryllium areas
- Moving equipment that may expose previously inaccessible surfaces that may be contaminated with beryllium,

THEN contact with the FOD IH Office.

[4] IF any of the following radiological conditions exist:

- Performing work in radiological areas, Radiological Buffer Areas, and areas posted to contact RADCON prior to working above 8 feet
- Moving equipment that may expose previously inaccessible surfaces that may be contaminated with radiological material
- Disturbing surfaces in/identified as Fixed Contamination Areas
- Disturbing surfaces of yellow-tagged material and suspect older items,

THEN contact the FOD RADCON Office for an RWP.

[5] Obtain appropriate review of the JHA and BWP(s) or RWP(s) to ensure there are no conflicts or new hazards introduced by the BWP or RWP PPE requirements and controls.

[6] Document the BWP or RWP number(s) and the SME review.

5.0 PERFORMANCE ACTIVITIES

NOTE 1 *Performance activity sub-sections may be performed independently or omitted, as required.*
NOTE 2 *All non-conformances are to be documented by a Nonconformance Report (NCR) or by affixing reject tags.*

5.1 Vessel Inspection Prior to Service

Inspector (alternatively, may be performed by CPSO or delegate)

[1] Check for the presence of nameplate and other manufacturer's markings/stamps.

[2] Inspect (visually) vessel, connecting piping, and structural supports for damage and obvious defects such as dents, bulges, etc.

[3] Verify that any modifications (welded brackets, etc.) were performed under appropriate qualification stamp (this requires the original manufacture document U1 or U1A forms as a baseline).

NOTE *Pressure relief device shall be set **NO** higher than the Maximum Allowable Working Pressure (MAWP) of the pressure vessel.*

[4] Ensure required pressure relief device(s) are inspected in accordance with PMI below.

- **[a]** **IF** testing is required, **THEN** ensure pressure relief device is removed and tested in accordance with PMI below.
- **[b]** Ensure reinstallation of pressure relief device, as necessary.

[5] **If not already completed, e**stablish an inspection folder in EDMS or DMAPS for each to include manufacturer's data report, inspection reports, and other pertinent information (e.g., service media history and pressure and temperature cycle history; this may dictate specific examination requirements for example hydrogen embrittlement)

[6] Obtain and affix proper equipment identification tag to vessel and pressure relief device.

The MSS Document "Inspections and Testing of Pressure Vessels and Pressure Relief Valves" is O&M Criterion 419 (internal only).

Work instructions 40-25-040 "Pressurized Tank Relief Valve Testing", 40-25-041 Pressure Vessel Relief Valve Testing

5.2 Site-Fabricated Vessel Inspection Prior to Service

NOTE: *Such vessels are generally not allowed at LANL; contact CPSO before undertaking.*

Inspector

[1] Ensure the required nondestructive testing is performed by qualified personnel and recorded as required.

[2] Inspect vessel after installation or prior to service in accordance with Section 5**.1**, *Vessel Inspection Prior to Service*.

[3] Perform the hydrostatic (Section 5**.8**) or pneumatic (Section 5**.9**) pressure test, as required.

5.3 External Inspection

Inspector

[1] Initiate DMAPS Checklist by recording all available requested information.

[2] Review any previous vessel inspection reports to identify areas of concern and to determine if previously identified deficiencies have been corrected.

[3] Contact the vessel owner/user, as necessary, to determine and consider the service history of the vessel and other vessels in the same service since the last inspection.

[4] Check for the presence of nameplate and other manufacturer's markings/stamps.

[5] Check insulation coverings, supports, or settings for evidence of leakage.

[a] *If external coverings such as insulation or corrosion-resistant coatings are in good condition and no reason exists to suspect any unsafe condition underneath the coverings, removal is not necessary for inspection. However, it is advisable to remove small portions of the coverings (e.g., UT ports) in order to investigate the condition of the coverings and vessel surface.*

NOTE *Due to significant time requirements, Step 5**.3[6]** may be performed concurrently with the remainder of this section.*

[6] **IF** evidence of leakage (including in the past) is found, **THEN** perform the following in any order.

- Reject vessel pending further inspection
- Inform vessel owner of observation(s)
- Investigate leakage source completely until the source is established/known.

[7] Check structural attachments and supports (e.g., legs, saddles, skirts, hangers) for the following:

- Freedom for expansion and contraction, as applicable
- Anchor bolts and nuts for corrosion or defects
- Distortion
- Protective coating for evidence of blisters, peeling, or corrosion
- Excessive cracks or settlement on concrete pads, piers, or saddles
- Rot deterioration of wood support structures
- Cracks or other defects in weld areas
- Electrical grounding, for corrosion and other defects.

[8] Inspect vessel connections as follows:

[a] Examine manholes, reinforcing plates, nozzles, or other connections for cracks, deformation, or other defects.

[b] Inspect bolts and nuts for corrosion and other defects.

[c] Examine accessible flange faces for distortion and evidence of leakage.

[9] Check the surface of the vessel (shell, heads) for the following conditions:

- External corrosion[2]
- Dents
- Distortion[3]
- Erosion
- Cuts or gouges[4]

---

[2] Cosmetic (non-failing) anomalies:

- Surface corrosion where no pitting corrosion or significant loss of vessel wall material is observed
- Protective coatings that are scratched or peeled

Significant anomalies that to be reported (may require corrective action):

- Protective coatings bubbled or blistered
- Protective coatings that have disbanded and exhibit corrosion beneath
- Surface areas in which a representative sample area (approx 1 sq ft) exhibits ~1/6 or greater of the area rusted

[3] Evaluate to API 579

- Cracks, blisters, or bulges, on shell and head surfaces
- Weld areas for cracks and other defects.[5]

[10] Examine inlet and outlet piping and fittings for the following:
- Provisions for expansion
- Provisions for adequate support
- Evidence of leakage
- Proper alignment of connections
- Evidence of corrosion, erosion, cracking or other detrimental conditions.

[11] Verify proper operation and condition of vessel instrumentation, pressure gauges, controls, sight glasses, and blow-down drains.

[12] Inspect stop valve stems, hand wheels, and extension rods for excessive wear and damage.

NOTE *All pressure vessels are required to have a means of overpressure protection*[6]

[13] Check overpressure protection devices for the following:
- Proper type
- Proper size
- Leaks, corrosion, or damage
- Connecting bolts intact
- Deposits or material buildup
- Overdue test (PRVs) or expiration of service life (burst discs)
- Vent and/or drain lines are clear of obstructions and discharge to a safe location (when practical)
- Relief valves are directed or shielded so personnel in normal working areas will not be impinged by discharge
- Seals for adjustments are intact and show no evidence of tampering
- Set pressure is no higher than MAWP of pressure vessel, EXCEPT for rupture disks rated at temperatures above 100ºF.

[14] Verify installed pressure relieving device(s) are within required inspection/testing/calibration frequency.

[15] Perform UT thickness testing of components per Section 5.4 and complete corrosion rate and DMAPS remaining life calculation form.[7]

5.4 Thickness Measurement

Inspector

[1] When thickness measurement is required or **IF** it is determined that an internal inspection is impractical, cannot be performed, or would present excessive hazards to the Inspector[8], **THEN** perform external thickness measurements as follows:

---

[4] Ibid.
[5] Magnetic particle and liquid penetrant may be used to supplement visual inspection by an ASNT-qualified individual
[6] Excepting Code Case 2211 and UG-140
[7] Required to determine next inspection interval; not less than ½ of the remaining life of the vessel
[8] This is where ESM Chapter 17 Section I allows given when API 510 or NBIC allows on-stream [external and wall thickness] in lieu of internal.

[a] Perform external thickness measurements to include those areas where pitting and corrosion are evident or expected, **AND** document in DMAPS

Note: External thickness measurement is not valid for laminated vessels.

NOTE *An NCR shall be prepared if minimum allowable thickness data cannot be determined from manufacturer's data or documentation by Engineering.*

[2] **IF** thickness measurements are performed, **THEN** compare the measurements obtained to the minimum allowable wall thickness as identified in the manufacturer's data report or as determined by Engineering.

5.5 Internal Inspections, Preparing for

Inspector

[1] Obtain authorization **AND** coordinate scheduling of pressure vessel inspections and associated outages with the appropriate equipment owner(s).

[2] Ensure external inspection has been performed in accordance with Section **4.3**, *Vessel External Surface Inspection.*

[3] Ensure the required lockout/tagout permits are in effect; the vessel has been adequately shut down; and is isolated by closed, tagged, and locked stop valves, or by blanked off pipelines prior to entry.

[4] Ensure the removal of fuses, locking of controls, and blocking of movable parts on rotating type vessels or vessels with movable internal parts.

[a] Ensure such controls and movable parts are included in any lockout/tagout permits.

WARNING

Failure to purge vessel or adequately remove surface residue can cause death or serious injury due to asphyxiation or inhalation of toxic gases or vapors.

[5] Ensure the vessel has been drained, ventilated, and cleaned prior to internal inspection.

[6] Ensure applicable confined space entry permits are in place in accordance with confined space entry program.

[7] Ensure the internal atmosphere (oxygen content, etc.) has been analyzed by Industrial Hygiene and that IH has deemed the vessel safe for entry.

[8] Remove the inspection plugs and covers, as necessary, to allow a thorough examination of internal surfaces.

[9] Use adequate lighting to ensure visibility.

[10] Ensure adequate surface preparation so residue will not interfere with determining the true condition of the base metal.

5.6 Internal Surface Inspection

Inspector

[1] Examine internal surface conditions that could adversely affect the safety and dependability of the vessel, such as:

- Pitting
- Distortion
- Corrosion

- Grooving
- Erosion
- Dents
- Cuts or gouges
- Blistering
- Cracking
- Flaking
- Heat affects

NOTE *Where there is evidence of leakage or defects/deterioration are suspected, insulation or lining may require removal to the extent necessary to make a complete investigation.*

[2] Examine appurtenances, such as baffles, screens, and hangers for loose parts, loose or broken bolts, and excessive corrosion.

[3] Examine rotating equipment such as agitators or pump impellers for:

- Evidence of abrasion
- Scoring
- Misalignment
- Cracked mountings.

[4] Check any stays and braces for:

- Looseness
- Corrosion
- Cracks
- Breakage
- Bowing
- Leakage at upset and fastened ends.

[5] Examine manholes and other openings that are flanged or screwed into the vessel for cracks, corrosion, deformation, or evidence of leakage and check bolts and nuts for corrosion or defects. **IF** the pressure vessel is equipped with quick-actuating closures, **THEN** inspect for excessive wear/distortion **AND** ensure the proper function of the holding and locking elements.

[6] Examine all openings to external attachments such as gauge glasses, safety valves, and pressure or temperature controls to assure freedom from obstructions.

[7] Examine coils, tubes, and tube sheets for corrosion, erosion, scale, and other deposits.

[8] Examine rolled, flared, beaded, or sealed tube ends.

[9] Inspect the tube sheet for cracks in the ligaments between tube holes.

[10] Inspect visibly accessible gasket seating surfaces for cleanliness, leakage, and surface defects such as pitting or grooving.

[11] Check protective linings for cracks, tears, and other signs of deterioration. Vessels with special lining will require the use of special instruments to evaluate the lining. For example, glass-lined vessels will require high potential voltage equipment.

[12] Inspect external heating or cooling jackets and coils for defects and/or distortion resulting from over pressurization.

[13] Inspect cathodic protection (anode and cathode, if present) for evidence of excessive deterioration.

[14] Check gaskets and sealing surfaces for evidence of leakage and continued serviceability.

[15] Ensure adequate preparation of the surface and perform thickness measurements (or other non-destructive evaluations) to include those areas where pitting and corrosion are expected or evident, **AND** document measurements in DMAPS.

NOTE *An NCR shall be prepared if minimum allowable thickness data cannot be determined from manufacturer's data or documentation by Engineering.*

[16] **IF** thickness measurements are performed, **THEN** compare the measurements obtained to the minimum allowable wall thickness as identified in the manufacturer's data report or as determined by Engineering.

5.7 Repairs and/or Alteration Inspection

NOTE *Repair of vessels is generally not allowed at LANL; contact CPSO before undertaking.*

Inspector
NOTE 1 *The following steps may be performed in any order.*

[1] Ensure all applicable (completed) repair forms (R-1, R-2, R-3, etc.) and other pertinent information is present in equipment file(s).
[2] Inspect vessel after installation or prior to service in accordance with Section 5**.1**, *Vessel Inspection Prior to Service*.
[3] Perform or witness the hydrostatic (Section 5**.8**) or pneumatic (Section 5**.9**) pressure test, as required.

5.8 Hydrostatic Testing

NOTE 1 *Hydrostatic testing is usually required for post-fabrication, alteration, and repairs prior to the "R" or "U" stamp being applied. Hydrostatic testing is **NOT** normally required for in-service inspections. When hydrostatic testing is performed during in-service inspections, the original test pressure shall **NOT** be exceeded.*
NOTE 2 *Use Appendix A, Pressure Test Record, or equivalent.*

Inspector
[1] Ensure the pressure gauges used by the Inspector have current calibration stickers.
[2] Remove all persons not directly involved from the immediate test area.
NOTE *The designated test pressure for new construction, repair, and alterations is specified in the design documents. For in-service inspections, it is a pressure designated by the Inspector which does not exceed the MAWP stamped on the vessel. (NBIC NB-23 Vol 3, 4.4.1 allows 150% of MAWP)*
[3] Determine (establish) test pressure.
[4] Remove pressure relief valves or non-reclosing relief device from the vessel or test boundary where the test pressure will exceed the set pressure of the valve, **OR** hold down each valve disk by means of an appropriate test clamp and pressurize both sides of non-reclosing relief devices. Install temporary, higher-rated devices where practical.
[5] Install the calibrated test gauge so it is visible to the Inspector at all times.
[6] Ensure the skillet blanks or test plugs or clamps are appropriate for use and are free of obvious defects.

[7] Ensure the metal temperature for the hydrostatic test is between 60°F and 120°F inclusive or other temperature range as specified by Engineering.
[8] Fill and vent system as necessary to remove as much air from the vessel as practical.
[9] Pressurize the vessel, raising the pressure in the vessel gradually until the designated test pressure is achieved.
[10] Maintain this test pressure for ten minutes prior to inspection (NBIC NB-23 Vol 3, 4.4.1) then, if testing above MAWP, reduce to MAWP while making a full and thorough inspection for leaks.

NOTE *Engineering is to be contacted when structural distortion of the vessels is observed.*

[11] **IF** there is evidence of structural distortion, **THEN** reject the vessel.
[12] **IF** there is leakage in the vessel, **THEN** perform the following as appropriate:

- Ensure minor repair is performed **AND RETURN TO** Step 5**.8[1]**
- Contact Engineering for evaluation
- Reject the vessel.

[13] **WHEN** the test is completed, **THEN** vent the test pressure to atmosphere. Return relief devices to normal configuration.

5.9 Pneumatic Testing

WARNING
Stringent control of test pressure is required when using air or gas as a test medium to prevent over pressurization and potential injury/death.

NOTE 1 *Justification for using pneumatic testing instead of hydrostatic testing **SHALL** be reviewed and approved by the CPSO.*
NOTE 2 *Use Appendix A, Pressure Test Record*

Inspector
[1] Determine (establish) the test pressure.
[2] Ensure the pneumatic test pressure does **NOT** exceed the established test pressure of the vessel, unless otherwise specified in the Engineering design documents.[9]
[3] Remove from the immediate area all persons **NOT** directly involved in the test.
[4] Ensure the test area is properly flagged, barricaded, or otherwise controlled in accordance with LANL procedures to prevent unauthorized personnel entry.
[5] Install the calibrated test gauge so it is visible to the Inspector at all times.
[6] Ensure that the test gauge has a current calibration sticker.

NOTE *A pressure relief valve or non-reclosing relief device may be installed in the test medium supply line to ensure that this limit is not exceeded.*

[7] Verify that the pressure is continually monitored to ensure that pressure never exceeds the designated test pressure of the vessel.

[9] NBIC NB-23 Vol 3 4.4.1 "The test pressure shall be the minimum required to verify leak tightness integrity for the repair, but shall not exceed the maximum pneumatic test pressure of the original code of construction."

[8] Remove relief devices from the vessel to be tested, where the test pressure will exceed the set pressure of the device, **OR** hold down each valve disk by an appropriate test clamp and equalize pressure on non-reclosing relief devices.
[9] Pressurize the vessel, raising the pressure in the vessel gradually until not more than ½ of the test pressure is achieved.
[10] Increase the test pressure SLOWLY in steps of approximately 1/10 of the test pressure until the required test pressure has been reached.
[11] Reduce the pressure to the maximum operating pressure before proceeding with the inspection (see ASME Section VIII Div 1 UG-100). Hold the pressure for a sufficient period of time to permit inspection of the vessel.
[12] Check the pressure gauge periodically for indications of leakage.
[13] Apply a soap solution to accessible welds, screwed pipe joints, flanges, etc., where leakage is suspected.

NOTE *Engineering is to be contacted when structural distortion of the vessels is observed.*

[14] **IF** there is evidence of structural distortion, **THEN** reject the vessel.
[15] **IF** there is leakage vessel, **THEN** perform the following, as appropriate:

- Ensure minor repair is performed **AND RETURN TO** Step 5**.9[1]**
- Contact Engineering for evaluation
- Reject the vessel.

[16] Ensure personnel are clear **AND** vent the test medium to approved discharge vicinity/atmosphere.

6.0 POST-PERFORMANCE ACTIVITIES

6.1 Results

Inspector
[1] Complete DMAPS entry.
[2] Complete and forward Work Order and inspection checklist to the reports and data specialist.
[3] Include sketches or photographs with the inspection reports when necessary to depict more complex defects.
[4] Transmit a copy of the inspection report for accepted vessel to the owner and FOD PSO.
Define the when the next inspection is required based on the fitness for service evaluation. (see NBIC NB-23 5.3.7.1 10. & 19)
[5] Attach appropriate status tag to the equipment and contact equipment owner/user, as applicable.
[6] Generate non-conformance report, as necessary, for rejected vessels.
[7] Forward inspection documentation for rejected vessels to NDE team supervision for review/approval.
[8] Provide the owner/user with the completed inspection report and/or reject report, as necessary, **AND** file a copy of each in the work package. *Should also send a copy to the FOD PSO for the equipment files.*
Folder shall be kept in EDMS or PSCS as a Maintenance History Report with an appropriate numbering system (e.g. ,MHR-TABLDG-XXXX) and revised whenever inspection, test, or maintenance is accomplished

Supervisor/Designee

[9] Complete shop floor paperwork using biennial inspection frequency as a "default" frequency for accepted vessels, until the actual frequency determination is determined by DMAPS fitness for service feature or engineering.

NOTE *The following step may be performed at any time and independent of this procedure.*

[10] Perform the following actions upon receipt of the DMAPS determination of next inspection due date:

- **[a]** Ensure that CMMS is updated to reflect the next inspection due date.
- **[b]** Ensure the Inspector updates the equipment status tag in the field to reflect the next inspection due date, if applicable.
- **[c]** Place documentation of the determination in any central equipment file.

7.0 RESPONSIBILITIES

AET-6 or successor is performing organization; should responsible organizations change, applies to successor organizations. Performance may be subcontracted by AET-6, or by owners with AET-6 permission. Use by other LANL groups is allowed with permission of CPSO.

Other organization responsibilities as noted throughout.

8.0 IMPLEMENTATION

As noted throughout.

9.0 TRAINING

Lead inspectors shall be NBIC or API vessel inspection certified. NDE personnel working under their supervision shall be certified under ASNT SNT-TC-1A.

10.0 EXCEPTION OR VARIANCE

To obtain an exception or variance to this document, follow ESM Chapter 1 Section Z10 variance and exception process for procedures (e.g., CPSO may grant via email).

The requesting organization must maintain the official copy of record of the approved correspondence granting the exception or variance.

11.0 DOCUMENTS AND RECORDS

Records generated as a result of this procedure shall be maintained in accordance with LANL records policies.

AET-6 NDE Team

- DMAPS checklists and data

- Manufacturer's Data Report for Pressure Vessels if available, or engineering evaluation of minimum required wall thicknesses
- Non-conformance Reports (NCR)

12.0 DEFINITIONS AND ACRONYMS

12.1 Definitions and Acronyms

API	American Petroleum Institute
CMMS	Computerized Maintenance Management System (e.g., PassPort or Asset Suite)
CPSO	Chief Pressure Safety Officer
PSO	Pressure Safety Officer

For others see Chapter 17 (*Section GEN-1 Definitions*) and/or LANL *Definition of Terms* and *Acronyms and Names*.

13.0 HISTORY

This document supersedes any conflicting requirements in O&M Criterion 419 but the Criterion will remain in force and effect for each nuclear and high-hazard facility until that facility completes the Unreviewed Safety Question (USQ) or Unreviewed Safety Issue (USI) review determinations.

14.0 REFERENCES

- ANSI/NB-23, *National Board Inspection Code*
- American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code, Section VIII, Division 1
- API 510, *Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration*
- API 579, *Fitness for Service*

15.0 FORMS

A. Pressure Test Record (Sample)

16.0 CONTACT

Chief Pressure Safety Officer (*in ES-EPD*)
Telephone: (505) 606-2279 or 667-4657
Fax: (505) 606-0581
Location: TA-00, Building 0726, Room 200
E-mail: TBD
Website: Pressure Protection Program

FORM ADMIN-4-1-FM01

Pressure Test Record

SAMPLE from Chapter 17 Section REF-3 B31.3 Guide. Edit Word file with that Guide to suit but capture all data required for ASME Section VIII compliance.

TEST NUMBER:	PROJECT NO.:	PAGE 1 OF
PROJECT NAME:		
TEST INFORMATION		
SYSTEM DESCRIPTION:		
DESCRIPTION OF TEST BOUNDARIES: (Attach Sketch Showing Boundaries as Required. P&ID Recommended)		
DESIGN TEMPERATURE:	DESIGN PRESSURE:	
TEST METHOD: ☐ HYDROSTATIC ☐ PNEUMATIC:		
TEST FLUID:	APPLICABLE CODE:	
TEST REQUIREMENTS		
REQUIRED TEST PRESSURE:	TEST FLUID TEMPERATURE:	
REQUIRED TEST DURATION:	AMBIENT TEMPERATURE:	
GAUGE PRESSURE CALCULATION (See Section 4.2.4)		
ELEVATION DIFFERENCE BETWEEN GAUGE AND HIGH POINT:		
X CONVERSION FACTOR:		
PLUS REQUIRED TEST PRESSURE:		
EQUALS REQUIRED GAUGE PRESSURE:		
TEST RESULTS		

TEST DATE:	START TIME:	□ AM □ PM	
	FINISH TIME:	□ AM □ PM	
ACTUAL GAUGE PRESSURE:			
TEST EQUIPMENT			
TYPE:	RANGE:	CAL. DATE:	CAL. DUE:
REMARKS:			
TEST ACCEPTANCE			
CODE EXAMINER:		DATE:	
CODE INSPECTOR:		DATE:	

Hose Assembly Inspection (Guidance)

(convoluted, elastomeric, or braided)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	9/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Reference: RMA Hose Handbook IP-2 [1987] and National Propane Gas Association Flyers 114-91 & 134-81

All hoses should be visually, externally inspected prior to each use and thoroughly inspected prior to 12 months. All hose should be hydrostatically tested to 1.5 times Maximum Operating Pressure for 3 to 5 minutes every 12 months to verify the hose assembly's integrity. Hose prior to inspection must be cleaned, depressurized, and laid straight.

Inspection tasks

1. Look for cuts, gouges or worn spots in the hose cover that expose reinforcement braid.
2. Inspect for soft spots, bulges in cover, sections of crushed flat areas or kinked sections.
3. Carefully examine the first 18" of hose adjacent to both end couplings for damage such as kinks, soft spots, and bulges, cover cracks, permanent deformation, alignment, variations from the original form.
4. Check couplings for any slippage between the ferrule or hose and fitting body. Identify any indication of coupling motion.
5. Should the spring system protrude through the end fitting, the spring system is not working and the assembly has been damaged.
6. Check the coupling for worn threads, loose clamps or bands, worn gaskets or seal rings, worn or broken handles cam arms and pins.
7. Shake the assembly by hand. No component should rattle.
8. Inspect the hose cover for blisters and corrosion

If any of the above conditions are found, take hose out of service (tag or lock) and replace.

ADMIN-4-2 Hose Assembly Inspection Guidance

General Instructions for Hose Hydrostatic Testing

An inspection and hydrostatic test should be performed prior to each 30 hours of service or six months, whichever is sooner. The assembly must be clean prior to test.

A visual inspection as described previously should be completed.

Basic Instructions:

1. Lay the assembly straight.
2. Fill the assembly with water.
3. Raise one end and run water through to purge the assembly of air.
4. Cap and pressurize the assembly to 1.5 times Maximum Operating Pressure.
5. Maintain pressure for 10 minutes.
6. Any indication of leakage is cause for failure.
7. Drain and flush with alcohol to remove traces of water.
8. Allow drying if alcohol is not compatible with product.

Safety Warning:

Before conducting any pressure test on hose, provisions must be made to ensure the safety of personnel performing the test and to prevent any damage to property. Only trained personnel using proper tools and procedures should conduct pressure tests.

1. Air or other compressed gasses should not be used for pressure test.
2. All air should be removed from the hose prior to test by bleeding the air through an outlet valve at the raised end of the hose.
3. Test only one hose at a time.
4. Restrain the hose being pressurized. Crushing the hose should be avoided. Place firmly anchored steel bars or straps on each side and supported above the hose at about 10-ft intervals to limit whipping should a failure occur. It is normal, and you should allow for, the hose to move due to the pressurization.
5. A failure may occur that ejects one or both fittings. Retaining walls or sandbags should limit this motion.
6. Personnel must be protected or removed from the test area. Hose whip or an ejected fitting could cause injury during a failure.

Proper Hose Storage

1. Hose assemblies are made of material resistant to aggressive chemical attack consistent with the intended application. There is no shelf life. The product does not age. An accumulation of microbes has been observed due to thermal cycling in humid environments. This accumulation has proved very difficult to remove. Store hose assemblies in a clean, dry place where temperature cycles infrequently through a range no greater than –30 to 125 °F. The outer cover becomes stiff at cold extremes and may crack when flexed. Warm before flexing.
2. Avoid physical damage during storage by storing in a straight rigid tube or in a gentle coil that spirals in a radius larger than the minimum bend radius. Never stack material that will crush the hose.
3. Protect the assemblies from boring insects and gnawing rodents.
4. Good housekeeping that prevents exposure to process or foreign solids and fluids will reduce the required cleaning when the hose goes into service.

Pressure Regulator Maintenance (Guidance)

RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	09/17/2014	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Standards POC for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC and Committee**

This document is online at http://engstandards.lanl.gov

Regulator maintenance is an important part of maximizing your system's performance and extending the service life of system components. A maintenance schedule is the frequency at which recommended maintenance operations should be performed. Adherence to a maintenance schedule should result in minimizing downtime due to regulator failure as well as enhancing safety in the work area. Regulator service defines the gas service in which the regulator is installed in terms of its corrosive nature. There are three categories: noncorrosive, mildly corrosive, and corrosive. Establishing the category a regulator fits into can be difficult.

Recommended Schedule - This schedule should be used as a general guide. Be sure to follow the manufacturer instructions supplied with your regulator.

Service	**Function Test**[5]	**Inert Purge**	**Leak Check**[5]	**Creep Test**	**Overhaul**	**Replacement**[1,2]
Noncorrosive	prior to use	NA	monthly	annually	5 yrs	10 yrs
Mildly Corrosive[4]	prior to use	at shutdown	1-2x/month	6 months	3-4 yrs	6-7 yrs
Corrosive[4]	prior to use	at shutdown	2x/month	3 months	1-2 yrs[3]	3-4 yrs[3]

[1]More frequent overhaul or replacement may be required for regulators installed in a corrosive ambient environment.
[2]If diaphragms are neoprene or other elastomer, they may dry out and require more frequent replacement.
[3]If regulators are not properly installed and used, or a poor grad of gas is used, or purging is not properly done, overhaul and/or replacement may be required more frequently.
[4]For regulators used in toxic or corrosive gas applications, ensure proper precautions are followed as recommended by the manufacturer; e.g., don't use a self-venting regulator with ambient discharge.
[5]Leak testing is required when bottles are changed, maintenance is performed, or system configuration is changed.

In addition, a pressure regulator should also be checked after cylinder changes or system maintenance. The user is solely responsible for determining the frequency of maintenance based on the application, that the recommended checks can be safely performed, and that the recommended checks are adequate to ensure proper and safe operation of the user's system. **A regulator that does not comply with the recommended checks or malfunctions in any manner must be immediately removed from service. Do not attempt to repair the regulator.**

Glossary

Creep	A gradual increase in outlet pressure above the setpoint and occurs two ways: Changes to the motion of the regulator springs when gas flow is stopped Foreign material becomes lodged between the poppet and seat preventing tight shutoff Gas
Drop	a change in outlet pressure from a no flow to a flowing condition while the inlet pressure remains constant.
Inlet Pressure	The pressure measured immediately at the regulator entry.
Outlet Pressure	The pressure sensed at the regulator's outlet port.
Rise	An increase of outlet pressure as the inlet pressure decreases

Maintenance Checks

Function Test

1. Check the regulator function. Confirm delivery pressure increases when the adjusting knob is turned clockwise and decreases when turned counter-clockwise. To decrease delivery pressure the system must be flowing or vent the downstream system.

2. Check flow shutoff. Confirm after flow is stopped, that delivery pressure does not exceed the regulator's maximum outlet pressure.

Inert Purge

1. To increase regulator life use an inert gas to purge regulators that are used with corrosive or reactive materials after each use. Depending on the type of regulator for an effective purge, it may be necessary to fully reduce and re-pressurize the regulator body.

Leak Test

1. Check for regulator seat leak. Leak test methods should be appropriate for the system leak integrity requirements. Suggested method: Fully close the regulator by turning the adjusting knob counter clockwise until the stop is reached. Apply pressure to the regulator inlet. Close the upstream supply valve. Monitor the pressure between the supply valve and the regulator for 5 minutes. The pressure should not decrease.

2. Check for leaks to atmosphere. There should be no leaks to atmosphere. Leak test methods should be appropriate for the system leak integrity requirements. For example with an inert gas - With a regulator under pressure (both high and low pressure side) check all connections for leaks using a gas bubble leak check solution (Scott Model 46-B Series or Snoop®). If a leak is detected, shut down the gas source, reduce pressure to atmospheric, and tighten or redo the leaking connection.

Creep Test

1. Regulator creep is a phenomenon in which delivery pressure rises above a set point. Creep can occur in two ways. The first is due to changes in the motion of the regulator springs when gas flow is stopped. When flow has stopped, the springs must move to a new position of equilibrium, causing a slight increase in delivery pressure. This type of creep may be thought of as the opposite of droop. The second and more insidious type of regulator creep is caused by foreign material being lodged between the poppet and seat, thus preventing tight shut-off.

2. The result is that inlet and delivery pressure can equalize across the regulator, exposing all tubing and instrumentation to the inlet pressure. Regulator creep as a result of seat failure due to foreign material is the single most common cause of regulator failure. In order to prevent costly damage to the gas delivery system and the instrumentation it serves, care must be taken to ensure that regulator connections are capped to protect against ingress of dirt or foreign material. Tubing should also be flushed or blown clean to remove any foreign matter. A pressure relief valve should be installed downstream of the regulator as additional protection against creep.

3. To creep test, isolate the downstream side of the regulator by closing the regulator outlet valve, instrument valve or process isolation valve. Close the regulator by turning the adjustment knob counterclockwise until it reaches stop or rotates freely. Slowly turn on the gas supply. When the regulator inlet gauge registers full cylinder delivery pressure, shut off the gas supply. Turn the regulator adjusting knob clockwise until delivery pressure gauge reads approximately half of scale [e.g.,. 50 psi (3 bar) on a 100 psi (7 bar) gauge]. Close the regulator by turning the adjustment knob counterclockwise until it rotates freely or reaches the stop. Note the reading on delivery pressure gauge. Wait 15 minutes and recheck the setting on delivery pressure gauge. **If any rise in delivery pressure is detected during this time, the regulator is defective. Remove and replace.**

Proper Inactive Regulator Mode

A regulator should not be used as a shutoff valve. Close the supply valve or cylinder valve when equipment is not operating or is unattended, and vent and back out the regulator to the no flow condition.

A corrosive or reactive material is to be removed from a regulator by purging with an inert, during periods of in-operation.

A regulator is not to be left at a preset when a gas cylinder supply valve is opened. It should be at the no-flow condition.

Regulators should not be allowed to flow unrestricted to atmospheric pressure for any extended period of time. Such operation could result in excessive wear and improper regulator operation.

REF-1 – 10CFR851 on Pressure Safety

10CFR851.3 Definitions

Pressure systems means all pressure vessels, and pressure sources including cryogenics, pneumatic, hydraulic, and vacuum. Vacuum systems should be considered pressure systems due to their potential for catastrophic failure due to backfill pressurization. Associated hardware (e.g., gauges and regulators), fittings, piping, pumps, and pressure relief devices are also integral parts of the pressure system.

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.

From FR Vol. 71, No. 27, ~pg 6941, 2/9/2006

REF-2 – ASME Codes, Standards, Regulations, and Other References

This is a partial compendium of codes, standards, and other documents referenced this chapter.

ASME

1. **ASME Boiler and Pressure Vessel Sections**

Section I – Rules for Construction of Power Boilers

Section II Materials, Part A – Ferrous Material Specifications

Section II Materials, Part B – Nonferrous Material Specifications

Section II Materials, Part C – Specifications for Welding Rods, Electrodes, and Filler Metals

Section II Materials, Part D – Properties (Customary and Metric)

Section III – Rules for Construction of Nuclear Facility Components NCA General Requirements for Division 1 and 2.

Section III, Division 1 – Rules for Construction of Nuclear Facility Components

Section III, Division 2 – Rules for construction of Nuclear Facility Components (Code for concrete containments)

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 IV – Rules for Construction of Heating Boilers

Section V – Nondestructive Examination

Section VI - Recommended rules for the care and operation of heating Boilers

Section VII – Recommended guidelines for the care of power boilers

Section VIII, Division 1 – Rules for construction of pressure vessels

Section VIII Division 2 – Alternative rules for construction of pressure vessels

Section VIII, Division 3 – Alternative rules for construction of high pressure vessels (10,000 psig or greater)

Section IX – Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators

Section X – Fiber-reinforced plastic pressure vessels

Section XI – Rules for in-service inspection of nuclear power plant components

Section XII - Rules for construction and continued service of transport tanks

2. **ASME B31 Piping Codes – see ESM Chapter 17 Section ASME-1**

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 PTCPM – 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

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

ASTM International

ASTM A 380 – Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

ASTM G 63 – Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service

ASTM G88 – Guide for Designing Systems for Oxygen Service

ASTM G 93 – Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

ASTM G128 – Guide for Control of Hazards and Risks in Oxygen Enriched Systems

Code of Federal Regulations

TITLE 49—Transportation, Subtitle B--Other Regulations Relating to Transportation, Chapter I--Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Subchapter D--Pipeline Safety

Part 190--Pipeline Safety Programs and Rulemaking Procedures

Part 191--Transportation of Natural and Other Gas by Pipeline; Annual Reports, Incident Reports, and Safety-Related Condition Reports

Part 192--Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

Part 193--Liquefied Natural Gas Facilities: Federal Safety Standards

Part 195--Transportation of Hazardous Liquids by Pipeline

Part 199--Drug and Alcohol Testing

Department of Energy

DOE O 460.1C, Packaging and Transportation Safety [pipeline safety requirements; all transportation of hazardous materials by pipeline must be conducted in accordance with 49 CFR Parts 190-193, 195, and 199.]

DOE-STD-1020 DOE Standard, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities

LANL Conduct of Engineering

Administrative Procedures website (internal): https://coe.lanl.gov/APs/default.aspx

LANL Engineering Standards: http://enstandards.lanl.gov/

National Fire Protection Association

NFPA 54 – National Fuel Gas Code

New Mexico Administrative Code

NMAC 14.9.4.25, (*Housing and Construction, Mechanical Codes, Boilers*) issued by the Construction Industries Division of the Regulation and Licensing Department

NMAC Title 18 Part 60 (*Transportation and Highways, Pipeline Construction and Maintenance)* issued by the New Mexico Public Regulation Commission.

Occupational Safety and Health Standards (29 CFR 1910)

1910.253 Occupational Safety and Health Standards, Welding, Cutting, and Brazing, Oxygen-fuel gas welding and cutting.

ASME B31.3 Process Piping Guide

RECORD OF REVISIONS (AS REF-3)

0	9/17/2014	Initial issue. Previously Chapter 17 Section D20-B31.3-G; minor administrative changes.	Ari Ben Swartz, *ES-EPD*	Mel Burnett, *ES-DO*

DOCUMENT HISTORY

Rev	Date	Description	POC	OIC
0	11/5/02	Initial issue in Section 200 of LANL Engineering Manual Mechanical Chapter. Based on SRS guide.	Tobin Oruch, *FWO-SEM*	Kurt Beckman, *FWO-SEM*
1	6/9/04	Administrative changes to become ESM Mechanical Chapter Section D20 Appendix A.	Charles DuPrè, *FWO-DECS*	Gurinder Grewal, *FWO-DO*
2	3/10/09	Administrative changes to become ESM Pressure Safety Chapter 17 Section D20-B31.3-G	Charles DuPrè, *ES-DE*	Kirk Christensen, *CENG-OFF*

TABLE OF CONTENTS

PURPOSE 4

B31.3 INTRODUCTION....4

I - SCOPE AND DEFINITIONS....5

II - DESIGN 6

III - MATERIALS....16

IV -STANDARDS FOR PIPING COMPONENTS 16

V - FABRICATION, ASSEMBLY AND ERECTION....16

VI - INSPECTION, EXAMINATION AND TESTING....21

APPENDIX A – PIPING SPECIFICATIONS....26

APPENDIX B – FLUID SERVICE SHEETS 80

APPENDIX C – MATERIALS SELECTION 101

APPENDIX D – VALVE SELECTION GUIDE....106

APPENDIX E – FLANGED CONNECTIONS....119

APPENDIX F – ALIGNMENT FIT-UP TOLERANCES....127

APPENDIX G – COMPONENT IDENTIFICATION 132

APPENDIX H – LEAK/PRESSURE TESTING....140

APPENDIX I – STRESS ANALYSIS 145

APPENDIX J – FILLET WELD SIZES....151

APPENDIX K – CLEANING CARBON AND STAINLESS STEEL PIPE....156

APPENDIX L – BURIED PROCESS PIPE 162

APPENDIX M – MITERED JOINTS 163

APPENDIX N – BRANCH CONNECTIONS....165

APPENDIX O - SAFETY CLASS PIPING SYSTEMS 167

APPENDIX P – REPAIRS, MODIFICATIONS AND MAINTENANCE 168

APPENDIX Q - APPLICATION OF ASME B31.3 TO RADIOACTIVE FLUIDS....170

APPENDIX R – DEFINITION OF ACRONYMS....171

PURPOSE

This Guide provides information for the proper application of the ASME B31.3 Code "Process Piping," It was last updated for the 2002 edition. ASME B31.3 applies to process piping and tubing systems at Los Alamos National Laboratory (LANL). This Guide also contains ASME B31.1 and AWWA compliant Piping Specifications. Guide users are responsible for compliance with all aspects of the applicable Code. This Guide addresses only B31.3, however this guidance is typical of the requirements of other piping Codes.

The information contained in this Guide provides clarification to the Code text, additional information not contained in ASME B31.3, and design input specific to LANL. **This Guide is not to be used as a stand-alone document.** This Guide is formatted to be used in conjunction with ASME B31.3, by following the same section numbering as B31.3 Code. Appendix references herein are to this Guide, not B31.3 or the ESM, unless otherwise noted.

A user who desires clarifications on the application of piping related Codes and Standards should contact the LANL Engineering Standards Pressure Safety Point-of-Contact.

In the event of a contradiction between this and other ESM material, the other material shall have priority.

B31.3 INTRODUCTION

The Introduction to ASME B31.3 states "It is the owner's [Design Authority] responsibility to determine which Code Section is most applicable to the piping installation."

The other ASME B31 Code Sections and other common National Consensus Codes are listed in Table 1. Building and plumbing Codes as required by state and local jurisdictional requirements apply to potable water, and for sewer and drain systems that do not have a process function.

Table 1- National Consensus Codes and Standards for Piping

Organization	ID	Title
ASME	B31.1	Power Piping
ASME	B31.4	Liquid Petroleum Transportation Piping Systems
ASME	B31.5	Refrigeration Piping
ASME	B31.8	Gas Transmission and Distribution Piping Systems
ASME	B31.9	Building Services Piping
ASME	B31.11	Slurry Transportation Piping Systems
ANSI/AGA	Z223.1	National Fuel Gas Code (same as NFPA 54)
AWWA	C 100	Cast-Iron Pipe, Fittings
AWWA	C 200	Steel Pipe
AWWA	C 300	Concrete Pipe
AWWA	C 400	Asbestos Cement Pipe
AWWA	C 500	Valves and Hydrants
AWWA	C 600	Pipe Laying
AWWA	C 900	PVC Pressure Pipe
AWWA	M9	Concrete Pressure Pipe
AWWA	M11	Steel Pipe-Guide for Design and Installation
NFPA	Multiple	Fire Protection Systems

Guidance supplementing the Code is necessary because the Code provides no explicit rules for functional design, material compatibility with fluid and environment (erosion/corrosion protection, radiation effects, etc.), layout, serviceability, steam tracing, grounding, valve and component selections, design of pipe supports, material traceability, gasket selection, as-built tolerances, insulation, cleaning for special process, etc. Also, for certain services some options available through B31.3 must be excluded, made more stringent or supplemented by the designer.

Warning: The original and continued safe operation of a piping system depends on the competent application of codes and standards.

The **Owner and Designer are responsible** for compliance with the personnel and process qualification requirements of the codes and standards.

In particular, the application of ASME B31.3 requires compliance with the **Inspector** qualification requirements of ASME B31.3 Section VI for all fluid services (safety or non-safety related).

I - SCOPE AND DEFINITIONS

300(b) - Responsibilities

The following responsibilities are applicable at LANL:

1) Owner - The Owner is the Design Authority. See Acronyms and Definitions sections in ESM Chapter 1 Section Z10 and Chapter 17, Pressure Safety.
2) Designer - The Designer is the Design Agency.
3) One of the signoffs on a piping work package must reflect an **"Owner's Inspector"** review. This means:

   The person signing must have the minimum experience of 340.4(b), and

   The person signing must have verified, to the extent necessary, that code and engineering design requirements for examination and testing are met (341.4.1).

300(c) - Intent of the Code

1) The code addresses the structural integrity of the piping system. The designer is responsible for all other aspects of the design including the functional design of the system.
2) Recommendations for applying ASME B31.3 Code to repairs, modifications, and maintenance are provided in Appendix P.
3) Appendix B provides Fluid Service Sheets to assist in selection of materials for compatibility with common fluid services. Historical TA-55 Specification 4401-J-1 contains material recommendations for PF-4.

300.1.1 - Content and Coverage

1) ASME B31.3 may be applied to Radioactive Fluid Services. See Appendix Q.
2) Transfer lines between facilities (such as waste or steam transfer lines) that support processing functions may be designed and constructed to ASME B31.3.

300.1.3 - Exclusions

1) Note that paragraph 300.1.3 (a) does not exclude vacuum systems.

2) Radioactive fluids should not be excluded from ASME B31.3 Scope. See Appendix Q.

3) For fire protection, refer to the NFPA Codes and ESM Chapter 2.

300.2 - Definitions

1) Category M Fluid Service is recommended for safety class piping systems. See Appendix O.

2) Radioactive fluids should not be classified as Category D Fluid Service. See Appendix Q.

3) The Owner's Inspector is responsible for verifying the piping installation to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the Engineering Design. LANL Owner's Inspector(s) are designated by the Construction Engineering

4) Normal fluid service Piping Specifications (Appendix A) may be used in Category D fluid service.

5) Examiner - The person(s) certified by the employer as qualified to perform the quality control functions specified in ASME B31.3. The LANL ESM Chapter 13 specifies how NDE is processed at LANL.

II – DESIGN

301.1 - General

Of all the design considerations listed in 301, only pressure rating is covered in the Piping Specifications in Appendix A. The Piping Specifications provide materials, fittings, and fasteners, which meet the pressure design requirements of B31.3. The designer must address all design conditions.

301.2.2 - Required Pressure Containment or Relief

Piping systems are designed to either safely contain or relieve the maximum pressure that can be imposed. Plant fires can present a safety concern for certain piping systems. The installation of pressure relief devices should be considered for liquid systems greater than 6" ID that can have isolated fluid.

Helpful information is available in ESM Chapter 17.

301.5.1 - Impact

Piping systems must be designed to withstand anticipated fluid transients (waterhammers, pressure surges, etc.). These are the transients expected to occur during normal operation of the system. Piping systems cannot be designed for unanticipated transients. These are the transients that can occur if the system is not properly operated. Unanticipated transients must be eliminated by design (layout) and appropriate startup and operating procedures.

301.5.2/3- Wind and Earthquake

The applicable wind and earthquake requirements are defined LANL Engineering Standards Manual Structural Chapter 5.

301.5.4 - Vibration

New designs, modifications, repairs, replacements, should be visually inspected at startup to verify that vibration is not excessive. The rules of ASME "Standards and Guides for Operation and Maintenance of Nuclear Power Plants" OM-S/G, Part 3, can be used for guidance. The ASME OM document provides a methodology to evaluate vibration using high cycle fatigue analysis and can be applied to any piping system.

301.8 - Effects of Support, Anchor, and Terminal Movements

Soil settlement can adversely affect the integrity of a piping system and the flow in a sloped line. When proper slope is required to maintain flow in an underground piping system, soil settlements need to be evaluated in the design of the piping system.

302.2.1 - Listed Components Having Established Ratings

Tables 326.1, A326.1, and K326.1 provide a listing of standards and specifications that have been accepted by the Code. Some of these standards provide established pressure/temperature ratings for components (e.g., ASME B16.5). The components may be used in piping systems within the specified ratings without additional analysis. If these components are used outside established ratings additional analysis is required.

302.2.2- Listed Components Not Having Specific Ratings

Some standards and specifications provided in Tables 326.1, A326.1, and K326.1 base pressure/temperature ratings on equivalent schedule (wall thickness) of straight seamless piping less mill tolerance (e.g., ASME B16.11). The ratings of these components are addressed in the piping specifications provided in Appendix A. If these components are used outside the limits established in the piping specification additional analysis and documentation must be provided.

302.2.3 - Unlisted Components

The ASME B31.3 Code defines unlisted components as components not in Tables 326.1, A326.1, or K326.1. Unlisted components can have pressure ratings but the owner and/or the designer has the responsibility to verify that the design, materials, fabrication, examination, and testing of the component meet the requirements of ASME B31.3. Unlisted components are generally categorized as one of the following:

- Components built to Unlisted Published Standards,
- Components built to Manufacturers Standards, or
- Components built to Site Standards or Engineering Design.

Each of these categories is addressed below.

COMPONENTS BUILT TO UNLISTED PUBLISHED NATIONAL STANDARDS

Components built to other published National Standards may be used provided that the design, material, fabrication, examination, and testing have been verified to meet the requirements of ASME B31.3. The Code states that the pressure design must meet the requirements of paragraph 304 of B31.3. The rules described below for components fabricated at LANL should be followed when published National Standards are not acceptable.

COMPONENTS BUILT TO MANUFACTURERS STANDARDS

Components built to Manufacturers Standards have not been established by a consensus body and require a more detailed review than components built to Published National Standards. Many manufacturers build components for application in ASME B31.3 piping systems therefore, evaluations of the design, materials, fabrication, examination, and testing to B31.3 requirements is less difficult.

The pressure/temperature design of the component should provide the same safety margins as the Code. When evaluating these components the manufacturers should be contacted to determine what documentation is available for the components. Suppliers or distributors of the component may not understand the Code and may not be helpful in resolution of the issues associated with qualifications of the unlisted component. Manufacturers are the best source of information. If the manufacturer's documentation is not acceptable, the owner and designer must perform the component qualification. The rules described below for components fabricated at LANL should be followed when Manufacturers Standards are not acceptable. Another alternative is to select a different manufacturer to supply components that meet B31.3 requirements.

COMPONENTS BUILT TO SITE STANDARDS

Piping components that form part of the pressure boundary of a piping system, that are fabricated at LANL require qualification to the requirements of the B31.3 Code. The pressure design of these components is specified in paragraph 304.7.2 of the Code. The Code requires that calculations be performed to support the design of these components. These calculations must be consistent with the design criteria of the Code and must consider all applicable ambient and dynamic loads (ref. paragraph. 301.4 through 301.11). The Code also requires that the calculations be substantiated by one of the following methods:

- Extensive successful service of the component under comparable conditions including loading, environment and fabrication of like materials,
- Experimental stress analysis to code requirements,
- Proof testing to code requirements, or
- Detailed stress analysis to ASME B&PV Code Section VIII, Div. 2.

EVALUATION OF COMPONENTS FOR PRESSURE/TEMPERATURE RATINGS

The preceding describes actions to meet necessary Code requirements for unlisted components. All piping components in a B31.3 system must meet the minimum Code requirements for design, materials, fabrication, examination, and testing. The following guidance is provided for review of these areas when evaluating an unlisted component.

DESIGN

The rules in B31.3 address the pressure design of components in paragraph 304. The rules and equation in paragraph 304 can be applied to simple shapes, such as cylinders and other common piping geometry. Equations and rules for additional shapes can be found in the ASME B&PV Code Section VIII. The design methodology in Section VIII is acceptable for unlisted component analysis in B31.3. Additional methods used to evaluate unlisted components include the use of equations in "Roark's Formulas for Stress and Strain". The use of all these equations requires that the components be idealized into bounding shapes for which the equation is valid. Manufacturers generally use simple shapes in the design of components, to minimize fabrication costs.

Design qualification of unlisted components can also be accomplished by comparison to listed components with established pressure/temperature ratings. The comparison involves a review of the wall thicknesses and geometry to demonstrate that the unlisted component is bounded by a component with an established pressure rating.

MATERIAL

Typically, unlisted components are fabricated from B31.3 listed materials. However, when the materials are not listed by the Code, the material must be qualified in accordance with the requirements of the Code. Reviewing the material of an unlisted component is done to ensure a specified minimum allowable stress at the design temperature. The sources for allowable stress values include the ASME B31 Codes of Pressure Piping and the ASME B&PV Code Section II. B&PV Code Cases should also be reviewed for allowable stresses for specific materials. The material should also be reviewed for susceptibility to degradation mechanisms associated with the service conditions, including a review of brittle fracture.

FABRICATION

The processes used to fabricate unlisted components must also be reviewed for Code compliance. Some fabrication processes can cause gross or local wall thinning. If wall thinning is possible, thinning should be accounted for when the nominal thickness is specified. Additional fabrication allowances should be added to the required thickness to account for manufacturing processes. Examples of wall thinning include the 12½% mill tolerance that is applied to all piping and the allowances for wall thinning due to pipe bending and threading. If welding is used, the welders and welding procedure must be qualified to ASME Section IX. If bolting is used, torquing procedures should be consistent with Appendix E.

EXAMINATIONS

Unlisted components fabricated at LANL must be examined in accordance with the Code. Components that are mass-produced to manufacturer's standards may have statistical quality control methods applied. When components are built to manufacturer's standards that require examinations, the standard should be reviewed to ensure that the extent of required examination and acceptance criteria meet the Code requirements for the specified fluid service category. When manufacturers do not specify examination requirements, the design should be reviewed to ensure that adequate margin (i.e., wall thickness) exists above the minimum design requirements to address the lack of examination. To review this aspect, the Basic Casting Quality Factors, Table A-1A of B31.3, the Basic Quality Factors for Longitudinal Weld Joints, Table A-1B, and the Joint Efficiencies, UW-12 B&PV Section VIII, can be used as guidance in determining an adequate wall thickness for castings or components joined by welding.

TESTING

The B31.3 Code requires leak testing for all components. This test does not assess the structural integrity of the components. The Code leak test is performed at pressure levels that do not challenge the ultimate strength required by the Code. In most cases the component is subjected to the leak test after being installed in the field. All components should be reviewed to insure that their pressure/temperature rating is acceptable for the test conditions.

Some components will be qualified using a structural integrity test. The B31.3 Code accepts proof tests in accordance with the ASME B16.9, MSS SP-97, and ASME B&PV

Section VIII Division 1, UG-101. When components are qualified by proof test, the factor of safety between failure and the pressure rating should be as specified in the Code to which the component was tested. When a factor of safety is not specified, margins against failure that ensure safety equal to or superior to the intent of the ASME B31.3 Code must be applied.

INSTRUMENTS

Instruments are not in the scope of ASME B31.3. The Code defines the boundary to include all piping (tubing) and components used to connect instruments to other piping or equipment, but specifically excludes instruments. Instruments are usually purchased as pressure rated components. When evaluating instruments for use in pressure piping systems, the requirements of DOE Order 440.1A must be considered. This order states “When National Consensus Codes are not applicable (because of pressure range, vessel geometry, uses of special materials, etc.), implement measures to provide equivalent protection and ensure safety equal to or superior to the intent of the ASME Code.”

When evaluating instruments the designer should ensure that the instruments are selected to meet the requirements of the fluid service. Specifically, the instrument’s pressure/temperature rating must be equal to or exceed the design pressure and design temperature of the system. The attachment of the instrument to the piping system must meet the requirements of B31.3. When instruments are fabricated from piping components (e.g., flanges and spool pieces), the piping components must meet the requirements of B31.3.

OTHER LOADS

The design equations and rules in the B31.3 Code only address the pressure loading of components. Components must be designed for all applicable loads expected during the design life of the component. See paragraph 301 “Design Condition” of B31.3 for a listing of loads to be considered. At LANL, ESM Structural Chapter should be used to specify NPH loading.

302.3.5 Limits of Calculated Stresses due to Sustained Loads and Displacement Strains

Stress Analysis, for loading other than pressure, per ASME B31.1 is acceptable and recommended. When the B31.1 Code is used for the stress analysis, Paragraph 104.8 shall be used in its entirety. Appendix I provides guidance for stress analysis of piping systems.

302.3.5(c) Longitudinal Stresses S_L

The longitudinal stress S_L due to deadweight only can be kept within approximately 2300 psi if vertical hangers are spaced as shown in Table 2 (from ASME B31.1).

Table 2 - Spacing of Vertical Supports

Nominal Pipe Size NPS	Water Service ft.	Steam, Gas, or Air Service ft.
1	7	9
2	10	13
3	12	15
4	14	17
6	17	21
8	19	24
12	23	30
16	27	35
20	30	39
24	32	42

Notes:

1) Maximum spacing between vertical pipe supports for horizontal straight runs of standard and heavier pipe at maximum operating temperature of 750°F.

301 Does not apply where span calculations are made or where there are concentrated loads between supports, such as flanges, valves, specialties, etc.

302 The spacing is based on a fixed beam support with a bending stress not exceeding 2300 psi and insulated pipe filled with water or the equivalent weight of steel pipe for steam, gas, or air service. The pitch of the line is such that a sag of 0.1 in between supports is permissible.

303 Applied only for deadweight design. Other loading conditions must be evaluated.

302.3.6 - Limits of Calculated Stresses due to Occasional Loads

For accident (faulted) conditions and one-time non-repeated anchor motions, the allowable stress may be increased to:

$$S = \min(3S_h, 2S_y)$$

Allowables (S_h) are from B31.1 which are lower than B31.3.

304.1.2 - Straight Pipe under Internal Pressure

For the pipe size, schedule, material and design pressure/temperature combinations provided in the Piping Specifications, this section is met. **If the piping specifications in Appendix A are not applied for the pressure design, additional engineering calculations are required.**

304.2- Mitered Segments of Pipe

Additional calculations are required for mitered joints. See Appendix M for mitered joint evaluation methodology.

304.3 - Branch Connections

Additional calculations are required to determine necessary reinforcement. See Appendix N for branch connection evaluation methodology.

307 - Valves

A selection guide for valves is provided in Appendix D. This guide provides information to aid in selection of the proper valve for the intended fluid service.

308.4 - Gaskets

Appendix C provides information on gasket ratings to be used in the selection of gaskets. Appendix B provides some information on compatibility of gasket materials with common fluids.

309 - Bolting

Torque values for flanged joints are provided in Appendix E.

319.4 - Flexibility Analysis

Formal flexibility analysis is not necessary if:

1) The design temperature is at or below 150°F and the piping is laid out with inherent flexibility

304 The design temperature is at or below 250°F and the piping is analyzed for flexibility using simplified methods of calculation.

321 - Piping Support

Design of pipe supports are addressed in Standards such as Manufacturers Standardization Society of the Valve and Fittings Industry MSS-SP-58. Allowable stress levels for supports are provided in the AISC Manual of Steel Construction and the AISC Standard N690. N690 is normally reserved for safety class and safety significant systems. The ESM Structural Chapter provides more details for applications at LANL. Guidance for the design and modeling of piping supports is provided in Appendix I.

322 - Specific Piping Systems

In addition to the Code requirements, engineering practice has lead to rules of good design practice to provide for safe and cost-effective piping systems. The following are examples of such rules. These rules must be applied by competent engineers in accordance with approved procedures.

1) Arrangement

304.1 Piping should be grouped in banks, where feasible, and allow the most efficient support arrangement. Piping oriented in one direction should be located at the same general elevation, where feasible.

304.2 Piping arrangement should provide space for maintenance, inspection and repair of components (including disassembly).

304.3 Piping arrangement should provide access to operating areas, corridors, observation windows, manholes and handholes.

304.4 Piping should conform to plant clearances above floor and grade. A minimum clearance of 7'-6" is desirable.

305 Vents and Drains

305.1 Vents and drains should be ¾ " or larger and as short as practical.

305.2 Drains from process lines should be piped to an appropriate collection or disposal receptacle. Drains from steam systems should be piped to boiler feedwater system when economically justified. Otherwise, they should be properly flashed and piped to waste.

305.3 Valves should not be installed where safety/process function of a piping system can be impeded (e.g. tank overflow lines, relief valves, vacuum breakers, etc.).

305.4 Caps are needed if the vent and drain lines require pressure testing.

305.5 Caps are needed if the fluid service presents a contamination concern.

305.6 Vents located outside without caps should be configured so that rainwater won't collect in the end of the piping.

305.7 Leakage through vent and drain valves on capped lines is a safety issue. The pressure behind the cap can be a hazard for the worker during removal. If the cap is only needed for cleanliness a small hole can be drilled in the cap or a cover without pressure retaining capability may be used.

306 Steam Distribution (Traps and Strainers)

306.1 Steam traps and strainers should be selected, located and sized by the designer. Steam trap rated capacity shall have been determined by manufacturer using ASME Performance Test Code PTC 39.1.

306.2 A trap bypass should be installed only where a process requires uninterrupted operation and the condensate must be discharged into a closed system.

306.3 When a bypass is required on a bucket-type steam trap, the bypass valve must be placed above the trap to prevent loss of prime in the event of valve leakage.

306.4 End connections of traps and strainers should be the same as joints permitted in the design except strainer blow off connections and downstream piping may be threaded.

307 Buried Piping

307.1 See Appendix L for Guidance for the Design of Underground Process Piping Systems.

308 Pipe Hangers and Supports

308.1 Design and manufacture of standard pipe supporting elements (catalog items) should be per MSS-SP-58.

308.2 Design of Non-standard pipe supporting elements (beams, columns, welds, etc.) should be in accordance with the requirements as prescribed by the American Institute of Steel Construction standards. Unless otherwise specified, materials should be ASTM A36.

308.3 Painting and galvanizing are acceptable measures for corrosion control of piping supports. When galvanized supports are specified, the galvanizing should be applied in accordance with ASTM A123 or B633-SC4, Type 1. Coating should not be applied within (or should be removed from) one inch of weld areas. Painted or galvanized areas that have been damaged during installation should be recoated.

308.4 Unless otherwise indicated on design drawings or specifications, mislocated, punched or drilled holes should be restored by welding per AWS D1.1 Section 5.26.5. Mislocated holes may be left open or filled with bolting only with the written approval of the Designer.

309 Standard Pipe Sizes

309.1 The following pipe sizes (inches) are typical at LANL.

309.2 Non-typical pipe sizes NPS 3/8, 1-¼ , 3- ½ , and 5 may be used for connections to equipment, sprinkler systems and pipe jackets.

¼	1 ½	4	12	20
½	2	6	14	24
¾	2 ½	8	16	
1	3	10	18	

7) Valves

a) The designer is responsible for assuring that selected valves are adequate for the service. The Designer may select alternate valves better suited for the service. Guidance for valve selection is provided in Appendix D.

310 Threaded pipe nipples should be:

310.1 seamless

310.2 the same material as non-threaded pipe, and

310.3 of schedules as indicated in the Piping Specifications or by Design

311 Galvanizing

311.1 Galvanizing is acceptable when required for external corrosion protection.

311.2 Galvanizing of pipe should be per ASTM A53.

311.3 Galvanizing of flanges, unions, and fittings should be the hot-dip process per ASTM A153. Weld end fittings NPS 4 and smaller may be black and painted after welding. Flanges and Stub Ends that are hot dipped galvanized shall be refaced to the requirements of the original Design Standard following the galvanizing process.

311.4 Galvanizing generally is a more economical weather-resistant coating than sandblasting and painting for piping NPS 4 and smaller. When a piping system requires many welded fittings the cost of grinding to remove the galvanizing for weld preparation may be more costly than painting. Use of galvanizing as a protective coating should be considered only when galvanizing is compatible with the contents of the piping.

311.5 Support components may have a zinc electroplate coating in lieu of a hot dip galvanized coating. Electroplate zinc coatings are per ASTM B633 and should specify Service Condition (SC) 4 as the required thickness.

312 Gasket and Packing

312.1 The designer is responsible for assuring that the flange and valve gaskets and valve stem packing are adequate for the intended service. Guidance for the selection of gaskets for Fluid Service application is provided in Appendix B.

313 Erosion/Corrosion, Radiation, and Thermal Aging

313.1 The designer must consider the effects of erosion/corrosion, radiation, and thermal aging during the material selection process.

313.2 The designer must consider practices to minimize Chloride Stress Corrosion Cracking (SCC) of austenitic stainless steels. See ESM Pressure Safety Point-of-Contact.

313.3 When required by the design, austenitic stainless steel and other corrosion resisting alloys should be evaluated for resistance to intergranular corrosion. See ESM Pressure Safety Point-of-Contact.

314 Piping material limitations in radiological controlled areas:

314.1 Teflon thread lubricant (tape or dispersion) should be evaluated for suitability by the designer (see App C).

314.2 Plastic piping materials such as gaskets, packing, valve cavity liners, diaphragms, etc., should be evaluated for their suitability for use by the designer and substitutions appropriately specified in project drawings or specifications.

314.3 Piping joints that use degradable materials, such as gaskets, thread compounds, O-rings, etc., should be evaluated for suitability for use by the designer and substitutions appropriately specified in project drawings or specifications.

315 Aluminum Piping

315.1 When aluminum piping is joined to vessels or piping systems constructed of other metals, and the fluid handled is an electrolyte, there is a tendency for aluminum at the joint to corrode. This is a problem where the other metals are copper or carbon steel. This can be prevented by eliminating the metallic electrical path through the joint by one of the following methods:

315.1.1 Install a plastic flanged spool piece in the line. Check the adequacy of the plastic spool for pressure, temperature and chemical compatibility with the electrolyte. This method is preferred and has the advantage that sludge inside the line will not bridge the gap from metal to metal.

315.1.2 Install spool pieces of heavier wall aluminum pipe (for increased corrosion allowance). This method is especially suitable where the pipe is dismantled frequently for other reasons.

315.1.3 Install insulating flange kits (insulating gaskets, bolt sleeves and bolt head washers). The insulating material must be checked for chemical compatibility with the electrolyte.

315.2 Aluminum pipe should be insulated from carbon steel pipe supporting components. Examples of insulation are 15-pound asphalt-impregnated felt, plastic coated pipe supports, or galvanized pipe supports.

315.3 Aluminum flanges are not recommended. When used they should conform to the Requirements of ASME B31.3 Appendix L and be flat faced.

315.4 Threaded connections in aluminum piping should be avoided. Where fit-up to threaded equipment is required use minimum length schedule 80 pipe with one end threaded.

315.5 Thread pipe with clean, sharp dies reserved for use on aluminum only. Use cutting oil suitable for aluminum.

315.6 Aluminum piping should be handled carefully to avoid embedding iron and copper particles, which could cause pitting corrosion when in contact with an electrolyte.

316 Pump Piping

316.1 For horizontal pumps with suction lift, when suction line is larger than inlet nozzle. The following guidance applies:

316.1.1 A reducer should not reduce by more than one pipe size.

316.1.2 For greater reduction, use a fabricated reducer with 10^0 maximum included angle and qualify the reducer as an unlisted component.

316.1.3 When reducers are installed in suction lines use an eccentric reducer with the flat side on the top.

316.2 Elbows should not be installed directly on a pump's suction unless the elbow is equipped with straightening vanes.

316.3 The designer should comply with the maximum allowable pump nozzle loads where specified by the pump manufacturer.

317 Back Siphon/Backflow

317.1 Physical connections made between domestic water system and any industrial piping system, vessel, or other equipment should be designed and installed to prevent backflow and back siphonage. See ESM Chapter 6 Section D20, Cross Connection Control subsection.

III - MATERIALS

See Appendix C for general guidance for materials selection.

See Appendix O for additional material requirements for Safety Class Piping Systems.

Fluid Service Sheets are provided in Appendix B to provide guidance on the selection of material for compatibility with the specified fluid service.

IV -STANDARDS FOR PIPING COMPONENTS

326 - Dimensions and Ratings of Components

ASME B31.3 Table 326.1 (also A326.1 and K326.1) identifies component standards that are "listed." Unlisted components (components made to standards or specifications not identified in Table 326.1) must be qualified per ASME B31.3 paragraphs 302.2.3 and 304. Proof of qualification is the responsibility of the Owner (LANL Design Authority) or Designer (See Paragraph 302.2 of this Guide).

A component to be used in a Code application must be listed in the Code and marked to Code requirements. Marking requirements for common components are provided in Appendix G.

V - FABRICATION, ASSEMBLY AND ERECTION

328 - Welding

Welding requirements of B31.3 are met by following the requirements identified in the LANL Welding Manuals (Future).

328.5.2 - Fillet Weld

The minimum fillet weld sizes required by B31.1 and B31.3 for slip-on flange and socket weld connections are listed in Appendix J.

332 - Bending

1) The following guidance is provided for bending:

   a) Hot bending of piping should be performed in accordance with written procedures. Hot bending of austenitic stainless steels should be followed by a full solution anneal in accordance with written procedures.

   b) No bending should be performed at metal temperatures less than 40°F.

   c) Cold bending may be performed using hydraulic or mechanical bending machines. Bending machines should be qualified by test for pipe minimum wall and ovality.

   d) Mandrel and die used in bending stainless steel piping should be free of zinc.

   e) Pipe longitudinal welds should not be located within 30 degrees of the plane of bend measured axially from the pipe centerline.

   f) Necking as determined by reduction of the outside circumference should not exceed 4%.

   g) Creased or corrugated bends are not permitted.

   h) After bending, the finished surface should be free of cracks and substantially free from buckling, by visual inspection. Depth of wrinkles on the inside of the bend as determined from crest to trough should not exceed 1.5% of the nominal pipe size.

   i) Flattening or ovality of a bend, the difference between maximum and minimum diameters at any cross section, should not exceed 8% of nominal outside diameter for internal pressure and 3% for external pressure.

   j) Wall thinning in piping shall not exceed:

      i) 10% - Bend radius of 5 pipe diameters and larger

      ii) 21% - Bend radius of 3 pipe diameters.

   k) Wall thinning in tubing shall not exceed:

      i) 12% - Bend radius of 5 pipe diameters

      ii) 22% - Bend radius of 3 pipe diameters

      iii) 37% - Bend radius of 1.5 pipe diameters

318 Tube bending differs from pipe bending in that it is usually performed in the field with a manually operated bender. The following guidance is provided to ensure good results on each bend.

a) Measure and mark exactly, then insert tube in bender.

b) Always attempt to bend in the same direction. If backbending, be sure to compensate for tubing stretch or pickup.

c) Clamp tubing securely in bender.

d) Check to make certain that the length mark is tangent to the desired angle on the radius block or in line with the desired degree on the link member.

e) Bend accurately to the desired angle plus springback allowance.

f) Remove tube and check bend angle and measurement length.

335 - Assembly and Erection

1) For tolerances on fabrication, refer to the Pipe Fabrication Institute Standard ES-3, "Fabrication Tolerances".

319 Typical tolerances for erection (field installation) are the larger of 6" or D/2 for safety related piping and 12" or D for non-safety related piping, while maintaining code, design and vendor alignment and slope requirements. Tolerance must not affect the sequential location of components, and fittings.

320 The following general requirements apply to buried pipe:

a) For installation of buried process piping refer to Appendix L.

b) Permits from the New Mexico Environment Department and environmental impact reports for the DOE may be required.

c) Bedding material should be granular, well graded and capable of being compacted flat

d) Backfill or fill material should contain no rocks and stones larger than 3 inch in the greatest dimension and should be free of frozen lumps, vegetable matter, trash, chunks or highly plastic clay or other unsatisfactory matter.

e) As an option, Controlled Low Strength Material (CLSM or "flowable fill") may be substituted for bedding material, embedment material or backfill material.

f) Prior to excavation, the existing underground structures and/or utilities should be located.

g) Where the trench bottom is unstable or contains unsuitable material, this material should be excavated to a minimum depth of 6". The excavated material should then be replaced with suitable material, or CLSM.

h) Compaction testing of bedding (excluding CLSM materials) should be done at frequencies specified by design in any location specified by the cognizant inspection authority. Bedding sections failing to meet these specifications shall be removed and replaced, or reworked.

i) The minimum depth of cover shall be 30" (top of pipe to finished grade).

j) The minimum slope or grade indicated on design documents shall be maintained regardless of other installation tolerance.

k) The use of vertical installation tolerance shall not increase unvented high points unless these are explicitly approved.

l) Upon completion of installation, record the as-installed piping geometry to within the tolerance as shown below:

  i) Vertical plane = $\pm$ 1"

  ii) Horizontal plane = $\pm$ 3"

335.1.1(a) - Alignment (Piping Distortions)

Allowable misalignment and fit-up tolerances are provided in Appendix F.

335.1.1(c) - Alignment (Flanged Joints)

The allowable flange gaps per B31.3 are provided in Appendix E. Allowable flange rotations above those provided in the Code are provided in Appendix F.

335.2 - Flanged Joints

Refer to Appendix E for guidance on the proper installation of flanged connections.

335.3 - Threaded Joints

1) Threaded components and threaded ends are examined before assembly for cleanliness and continuity of threads and are in conformance with applicable standards.

321 Compound or lubricant used on threads is suitable for the service conditions and shall not react unfavorably with either the service fluid or the piping material.

322 Threaded joints to be seal welded are made up without thread compound or lubricants.

323 When design requires threaded piping to be seal welded, seal welds shall cover all exposed threads.

324 Installation of threaded joints involves the cutting of threads and assembly of the joint. Cutting threads with a hand threader involves the following steps. Threads may also be cut with a power threader.

a) Select the proper size of die.

b) Clean surface of pipe. Be sure the end is square and free of burrs. Tapering the end of pipe is helpful starting the dies.

c) Mount the threader on the pipe making sure that the taper is headed in the forward direction.

d) Use thread cutting oil.

e) Pressure should be applied to start dies on pipe.

f) The thread length is correct when the outer surface of die is even with the end of the pipe.

g) Remove die and clean threads with brush or rag.

h) Apply joint compound or tape that has been approved by the Facility for the application.

i) Hand tighten fitting, then tighten to required degree of tightness with correct wrench.

335.6. -(a) Expanded Joints and Special Joints

Special precautions should be taken for any piping system containing an expansion joint assembly.

1) The manufacturer's and/or designer's special installation instructions shall be followed.

325 Expansion joint assemblies should be carefully unpacked and erected to avoid mechanical damage to the assemblies while handling or rigging. Erection straps or

chains shall not be loaded against or connected to bellows elements, covers or any assembly hardware during erection.

326 Prior to connecting or installing an expansion joint assembly, the erector should inspect the assembly to insure that all factory-installed shipping bars, brackets or other locking devices are in place. No modification to or removal of these devices shall be permitted until after the piping system closures are completed.

327 The expansion joint assembly may be equipped with permanent tie rods or limit rods, which are necessary for the functional operation of the joint assembly. Where provided, these rods shall not be removed, nor their factory set lengths and clearances modified, without approval by the designer.

328 An expansion joint assembly shall not be exposed to hydrostatic test or pressure flushing operations until all permanent anchors, guides and restraints are installed on the piping system. Hydrostatic test or flushing pressure shall not be greater than the manufacturer's recommended test pressure. All temporary shipping bars or brackets should be removed prior to system pressurization.

335.6. - (b) Special Joint - Compression Fittings

Specialty fittings are considered as unlisted component but are acceptable for use where identified in the attached Piping Specifications. The following guidance is essential for the proper installation and maintenance of compression fittings. The following instructions are applicable to Swagelok and Parker fittings.

1) Ends must be cut square. The preferred method of cutting tubing is by hacksaw with suitable guide for squareness. Tube cutters should not be used for stainless steel due to work hardening.

329 Burrs must be removed inside and outside for proper entry into fitting and to prevent system contamination and or restricted flow.

330 Tube ends must be clean. Remove all filings, chips, and grit before attachment of fittings.

331 Tube line fabrication (bend angles and measured lengths) must be accurate so that the tube end easily enters the fitting in proper alignment. Do not force an improperly fitted tube line into the fittings.

332 The tube end must be bottomed against the shoulder in the fitting body. This is necessary to prevent movement of the tube while the nut forces the ferrule to grip the tube, and to seal through any imperfections that may exist on the outside tube surface.

333 Never permit the fitting body to rotate during tube end make-up. ***Two wrenches must be used***. Assemble port connectors to components first and hold with wrench while making up the tube joint. All types of union bodies must be held while each of the tube ends is made up.

334 Never attempt to make up by torque or feel. Always turn the nut the prescribed amount (listed below) regardless of the torque required.

Sizes 1/16" - 3/16"	¾ of a turn from finger tight
Sizes ¼ "- 1"	1 ¼ turns from finger tight

Note: Fitting end plugs require only ¼ " turn from finger tight make up in all sizes.

335.6. -(c) Remaking an Existing Joint

Remaking an existing joint is as important as the initial installation. The following instructions are provided for the remake of these joints.

1) A disassembled joint can be remade simply by retightening the nut to the position of the original make-up. For maximum number of remakes, mark the fitting and nut before disassembly.

335 Before retightening, make sure the components are clean and that the assembly has been inserted into the fitting until the ferrule(s) seats in the fitting.

336 Retighten the nut by hand. Rotate the nut with a wrench to the original position as indicated by the previous marks lining up. A noticeable increase in mechanical resistance will be felt indicating the ferrule is being re-sprung into sealing position. Then snug the nut 1/12 turn (½ hex flat) past the original position.

337 Check ferrule orientation when applicable.

338 Use gap gage when applicable.

VI - INSPECTION, EXAMINATION AND TESTING

340.4- Qualification of the Owner's Inspectors

Qualification of individuals performing the Owner's Inspector Function shall meet the requirements of this paragraph. Owner's Inspectors are designated by the Site Chief Engineer. Refer to the IFMP Training and Qualification Program ACP-T&Q-01 (future).

341.4 - Extent of Required Examination

"Examination" is not limited to welds. Records, materials, fabrication, erection pressure testing, as-built, must also be examined as specified by Code. Refer to Table 3 for a list of examination attributes and the extent of required examination.

Table 3 - EXAMINATION OF MATERIALS, FABRICATION AND INSTALLATION

Extent of Required Examination							
	Material	**Fabrication**	**Fabrication of Longitudinal Welds**	**Mechanical Joints**	**Erection**	**Complete system Meets Design (2)**	**Other Examinations**
Category D	Random	Random	Random	Random	Random	Random	Random (3)
Normal	Random	5%(5)	100%	Random(1)	Random	Random	5% Vol. (4)
Category M	Random	100%	100%	100%	Random	Random	20% Vol.
High Pressure	100%	100%	100%	100%	Random	Random	100% Rad.
Severe Cyclic	Random	100%	100%	100%	100%	Random	100% Vol.

Notes:
(1) When pneumatic testing is to be used, 100% of mechanical joints shall be examined.
(2) Includes any additional examination or testing required by engineering.
(3) Category D Systems require welds to be random visually examined.
(4) When brazed joints are used, 5% in-process examination is performed.
(5) Socket welds require 5% visual examination of final weld.
Note: Vol = Volumetric weld examination such as a radiograph or ultrasonic.
Rad = Radiography

Guidance of specific examinations other than welds is provided below. This is not intended to be an all-inclusive list of items to be examined.

MATERIAL

1) At point of installation, materials and components are sufficiently identified by markings, tags, or documentation to assure they are in accordance with the specified requirements and traceable to the required documentation.

FABRICATION

1) After bending, the finished surface should be free of cracks and substantially free from buckling, by visual inspection. Depth of wrinkles on the inside of the bend as determined from crest to trough should not exceed 1.5% of the nominal pipe size.

339 Thinning of wall thickness after bending and forming of pipe does not exceed the following: 10% for bend radii of greater than or equal to 5 pipe diameters, or 21% for bend radii of less than or equal to 3 pipe diameters.

340 Thinning of wall thickness after bending and forming of tube does not exceed the following: 12% for bend radii of greater than or equal to 5 pipe diameters, 22% for bend radii of less than or equal to 3 pipe diameters, or 37% for bend radii of less than or equal to 3 pipe diameters.

341 Necking down after bending and forming as determined by reduction of the outside circumference does not exceed 4%.

342 Flattening or ovality of a bend, the difference between maximum and minimum diameters at any cross section, does not exceed 8% of nominal outside diameter for internal pressure and 3% for external pressure.

343 Cold bending is done at a temperature below the transformation range.

344 No pipe bending is performed at metal temperatures less than 40^0F.

345 Hot bending is performed to a design approved procedure.

346 Longitudinal weldments are not located within 30 degrees of the plane of bend.

347 Welding examinations are per the LANL Welding Manuals (future).

FABRICATION OF LONGITUDINAL WELDS

1) Perform radiography for longitudinal groove welds required to have a weld joint factor E_i equal to or greater than 0.90.

MECHANICAL JOINTS

1) Threads in the bolts and nuts to be free from nicks, burrs, grit, chips, and dirt and well lubricated prior to makeup.

348 Bolts extend completely through their nuts.

349 Manufacturer's and designer's installation instructions for expansion joints has been followed, and all factory installed shipping bars, brackets, or other locking devices are in place and remain in place until after piping system closures are complete.

350 Any damage to the gasket seating surface which would prevent gasket seating has been repaired, or the flange replaced. Refer to Appendix E.

351 The nuts have been tightened in a staggered crisscross pattern and in increments of not more than 1/3 the total required torque.

352 No more than one gasket is used between contact faces in assembling a flanged joint.

353 Galvanized flanges must be refaced with the appropriate surface finish after galvanizing in complete.

354 Prior to bolt up, flange faces are aligned within 1/16" in./ft. (0.5%) measured across any diameter and flange bolt holes are aligned within 1/8" maximum offset. Refer to Appendix F for guidance on misalignment fit-up tolerance.

355 Sealing surfaces of the flare of flared tubing joints are examined for imperfections before assembly.

356 Where the manufacturer's instructions call for a specified number of turns of the nut, these shall be counted form the point at which the nut becomes finger tight.

357 Threaded components are examined before assembly for cleanliness and continuity of threads and for conformance of threads with applicable standards.

358 Compound or lubricant used on threads (for components and bolts) is suitable for the service conditions and shall not react unfavorably with either the service fluid or the piping material.

359 Threaded joints to be seal welded are made up without thread compound or lubricant.

360 When design requires threaded piping to be seal welded, seal welds shall cover all exposed threads.

ERECTION

1) Piping is not distorted to bring it into alignment for joint assembly.

361 Wedges are not being used to laterally contain or position pipe for closure fit-ups.

362 The amount and direction of cold spring, (defined as the intentional deformation of piping during assembly to produce a desired initial displacement and stress) is in accordance with the design values.

363 Support locations, type, and restraint direction are as specified in the design drawing.

364 Pipe slope has been maintained in the direction specified by the slope arrow and/or work point elevation indicated on the design drawing.

365 Changes in piping elevation have not impacted slope requirements, high point vents, or low point drains.

366 Upon completion of installation the as-installed piping geometry has been recorded on the design documents. Typical tolerances for erection (field installation) are the larger of 6" or D/2 for safety-related piping or 12" or D/2 for non-safety related piping, while maintaining code, design and vendor alignment and slope requirements. Tolerance must not affect the sequential location of components and fittings, or the centerline lengths.

367 Valves and other components are oriented as shown in design documents or manufacturer's requirements.

368 Insulation is installed as specified.

369 There are no visible defects, missing or damaged parts in piping, components, or piping supports.

COMPLETE SYSTEM MEETS DESIGN

1) Examination of erected piping for evidence of defects that would require repair or replacement, and for other evident deviation from the intent of the design.

370 Any additional requirements supplementing the Code as specified by the design.

371 Cleanliness of piping is in accordance with the requirements of the applicable standard or as specified by design.

OTHER

1) Welding examination requirements are per the LANL Welding Manuals (future).

341.4.1(b)(1)- Other Examinations

In-process examination may be substituted for volumetric examination on a weld-for-weld basis, if volumetric examination of a particular weld is prohibitive. This substitution cannot be granted across the board for a whole job.

Requirements for examinations of repairs and alterations of in-service piping are provided in Appendix P.

342- Examination Personnel

Examiners shall have training and experience commensurate with the needs of the specified examinations. The employer shall certify records of examiners employed, showing dates and results of personnel qualifications, and shall maintain them and make them available to the Inspector. Examinations other than welds shall be conducted per the PS Division requirements.

345 - Testing

Table 4 is a summary of the leak test requirements of B31.3. Refer to Appendix P for testing requirements associated with Repairs, Alterations, and Modifications.

Guidance for performing Leak/Pressure testing is provided in Appendix H.

TABLE 4 - LEAK TESTING MATRIX

For Initial Installations & Fabricated Subassemblies

Fluid Service/ Piping Type	Type of Test					
	Hydrostatic	**Pneumatic**	**Combined Hydro/Pneu.**	**Alternative**	**Sensitive**	**Initial Service**
Category D Metallic	Primary leak test method	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted for the hydrostatic or pneumatic leak tests (1)	Part of the Alternative Leak Test	May be used at the Owner's option in lieu of the hydrostatic leak test
Category D Non-Metallic	Primary leak test method	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted in lieu of the hydrostatic method when approved by the Owner.	Not Applicable	Not Applicable	May be used at the Owner's option in lieu of the hydrostatic leak test
Normal Fluid Service Metallic	Primary leak test method	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted for the hydrostatic or pneumatic leak tests (1)	Part of the Alternative Leak Test	Not Applicable
Normal Fluid Service Non-Metallic	Primary leak test method	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted in lieu of the hydrostatic method when approved by the Owner.	Not Applicable	Not Applicable	Not Applicable
Category M Metallic	Primary leak test method. Requires additional Sensitive Leak Test.	May be substituted in lieu of the hydrostatic method when approved by the Owner. Requires additional Sensitive Leak Test.	May be substituted in lieu of the hydrostatic method when approved by the Owner. Requires additional Sensitive Leak Test.	May be substituted for the hydrostatic or pneumatic leak tests (1)	Required to be used in conjunction with hydro, pneu, combined test methods, or as a part of the Alternative Leak Test	Not Applicable
Category M Non-Metallic	Primary leak test method	May be substituted in lieu of the hydrostatic method when approved by the Owner.	May be substituted in lieu of the hydrostatic method when approved by the Owner.	Not Applicable	Not Applicable	Not Applicable
High Pressure Metallic	Primary leak test method (2)	May be substituted in lieu of the hydrostatic method (2)	May be substituted in lieu of the hydrostatic method (2)	Not Applicable	Not Applicable	Not Applicable

(1) May be substituted for the hydrostatic or pneumatic leak tests provided: a) The Owner has determined a hydrostatic test would damage linings or internal insulation, or contaminate a process which would be hazardous, corrosive, or inoperative in the presence of moisture, or would present the danger of brittle fracture due to low metal temperature during the test. b) The Owner has determined a pneumatic test would present undue hazard of possible releases of energy stored in the system, or would present the danger of brittle fracture due to low metal temperature during the test. In either case approval of the ESM Pressure Safety Point-of-Contact must be obtained.

(2) Additionally the piping in the installed configuration must be tested to 110% of the design pressure.

APPENDIX A – PIPING SPECIFICATIONS

The attached piping specifications provide the required data to meet the pressure design requirements of the ASME B31.3 piping code. Additional requirements and competent engineering are required to provide a safe and complete piping system design. Additional requirements include material selection, functional design, system layout, component selection, support design, thermal expansion, stress analysis, examination and testing. These specifications must be used in conjunction with ASME B31.3 and this Guide to ensure a sufficient piping system design.

WARNING

Successful application of each piping specification requires the reading and comprehension of all applicable General Notes.

When these guides are not applied in the pressure design of a piping system additional calculations are required.

The Piping Specifications are organized as follows:

100 Series	Carbon Steels
200 Series	Stainless Steels
300 Series	High Alloy Steels
400 Series	Nonferrous
500 Series	Nonmetals
900 Series	Non-ASME B31.3 Codes

Required Input

The following input is required to select a piping specification. Figure A-1 illustrates the procedure for the selection of the correct piping specification.

DESIGN CODE

Most of the Piping Specifications address the ASME B31.3 Piping Code. The B31.3 Code Scope applies to the majority of process applications at LANL. Additional ASME B31.1 and AWWA piping specifications are provided to address applications specific to the scope of these Codes. The user is responsible for compliance with all aspects of the design Code being applied. This Guide addresses only B31.3, however this guidance is typical of the requirements in other Codes.

FLUID SERVICE CATEGORY

The fluid service (Category D, Normal, Category M, or High Pressure) is a term used in ASME B31.3 that considers the combination of fluid properties, operating conditions, and other factors that establish the basis for design of the piping system. The piping specifications were developed to address the requirements of ASME B31.3 Normal Fluid Service Category and/or Category D requirements. Normal Fuild Service piping specifications may be used for Category D fluid services without restrictions. The fluid service is indicated on each piping specification in the design parameters section. For Category M fluid services, and systems subjected to severe cyclic conditions, additional restrictions apply. These additional restrictions shall be addressed by Engineering. See Appendix M of ASME B31.3 for guidance in classifying the fluid service category.

MATERIAL AND CORROSION ALLOWANCE

Selection of suitable piping materials to resist deterioration in service is required to provide a safe piping design. A corrosion/erosion allowance will need to be determined to provide the required wall thickness. The corrosion allowance shall be specified by the letter suffix (A, B, C, or D) in the piping specification identification (e.g., PS-101A). The fluid service will also affect the selection of materials such as gaskets, valve seats and packing. Issues related to material selection should be addressed by Engineering. Guidance for material compatibility is provided in Appendices B and C.

DESIGN PRESSURE

The design pressure of a piping system is the pressure at the most severe condition of coincident internal or external pressure and temperature expected during service. Examples of the design pressure in a piping system include the deadhead pressure of a pump or the relief valve set pressure.

The most severe condition is that which results in the greatest required component thickness and the highest component ratings.

DESIGN TEMPERATURE

The design temperature of a piping system is the temperature at the most severe condition of coincident pressure expected during service.

With the above inputs, the different component options provided in the piping specifications can be used to meet the pressure design of a piping system. Selection of the different options provided in the piping specification (i.e. socket-weld vs. buttweld fittings, slip-on vs. weld neck flanges etc.) will affect the stress levels in the piping system. Components in an existing piping system shall be replaced in kind. If components are changed in an existing piping system these changes shall be addressed by Engineering. For new piping system design specific requirements for options shall be specified on the design drawings.

COMPONENTS

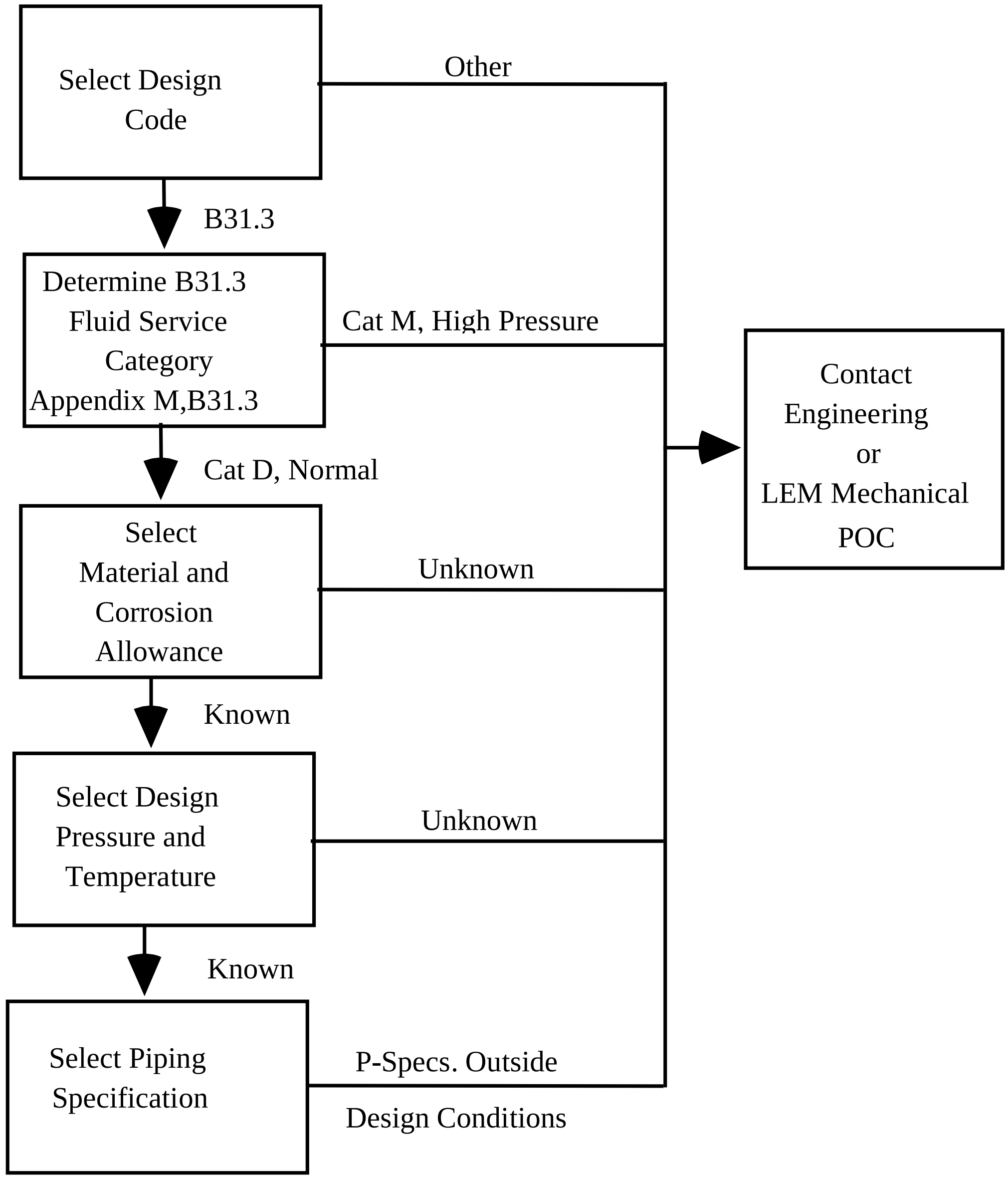
Piping components not provided in the piping specification can be selected from the standards listed in ASME B31.3.

Components of higher pressure rating may be used in the piping specification without additional analysis. All changes shall be documented on design drawings.

UNLISTED COMPONENT QUALIFICATION

Components used in piping systems not conforming to listed standards in B31.3 are considered unlisted by the Code and require additional qualification.

Figure A-1 Flow Chart for Piping Specification Applications



Piping Specification Revision Control Page

Piping Specification	Title	Revision	Description of Revision	Pages
PS-101	Class 150 Carbon Steel	0	Original Issue	1
PS-102	Carbon Steel (B16.3)	0	Original Issue	1
PS-103	Class 300 Carbon Steel	0	Original Issue	1
PS-104	Class 400 Carbon Steel	0	Original Issue	1
PS-105	Class 600 Carbon Steel	0	Original Issue	1
PS-106	Rating 1000 psi, Carbon Steel	0	Original Issue	1
PS-107	Class 1500, Carbon Steel	0	Original Issue	1
PS-108	Class 2500, Carbon Steel	0	Original Issue	1
PS-109	Victaulic Zero-flex, Carbon Steel	0	Original Issue	1
PS-200	Class 150 304L Stainless Steel	0	Original Issue	1
PS-201	Class 150 316L Stainless Steel	0	Original Issue	1
PS-202	Class 300 304L Stainless Steel	0	Original Issue	1
PS-203	Class 300 316L Stainless Steel	0	Original Issue	1
PS-204	304L Stainless Steel Tubing	0	Original Issue	1
PS-205	304L Stainless Steel Tubing	0	Original Issue	1
PS-206	316L Stainless Steel Tubing	0	Original Issue	1
PS-207	316L Stainless Steel Tubing	0	Original Issue	1
PS-208	Class 400 304L Stainless Steel	0	Original Issue	1
PS-209	Class 600 304L Stainless Steel	0	Original Issue	1
PS-210	Rating 600 psi, 304L Seamless	0	Original Issue	1
PS-211	Rating 600 psi, 316L Seamless	0	Original Issue	1
PS-212	Rating 1225 psi, 304L Seamless	0	Original Issue	1
PS-213	Class 1500, 304L Seamless	0	Original Issue	1
PS-214	Class 2500, 304L Seamless	0	Original Issue	1
PS-215	Victaulic Zero-flex, 316L 10S	0	Original Issue	1
PS-300	Class 150 Hastelloy C276	0	Original Issue	1
PS-301	Class 300 Hastelloy C276	0	Original Issue	1
PS-302	Class 150 Alloy 20	0	Original Issue	1
PS-303	Class 300 Alloy 20	0	Original Issue	1
PS-304	Class 150 Inconel 600	0	Original Issue	1
PS-305	Class 150 Inconel 690	0	Original Issue	1
PS-306	Class 150 Monel	0	Original Issue	1
PS-400	Copper Tubing Category D	0	Original Issue	1
PS-401	Copper Tubing - Class 150	0	Original Issue	1
PS-402	Copper Tubing - Type L	0	Original Issue	1
PS-403	Copper Tubing - B280	0	Original Issue	1
PS-404	Class 150 Aluminum Pipe	0	Original Issue	1
PS-405	Class 150 Aluminum Tube	0	Original Issue	1
PS-500	150 psi PVC	0	Original Issue	1
PS-501	150 psi CPVC	0	Original Issue	1
PS-502	200 psi Polyethylene (PE)	0	Original Issue	1
PS-900	B31.1 Class 150 Carbon Steel	0	Original Issue	1
PS-901	B31.1 Class 300 Carbon Steel	0	Original Issue	1
PS-902	B31.1 Class 600 Carbon Steel	0	Original Issue	1
PS-903	AWWA PVC	0	Original Issue	1
PS-904	AWWA Ductile Iron	0	Original Issue	1

General Notes

Successful application of each piping specification requires the reading and comprehension of all applicable General Notes.

1 This specification provides the necessary information to meet the pressure design requirements of the ASME B31.3 piping code. Additional requirements include, but are not limited to, support design, thermal expansion, material selection, examination, and testing. These additional requirements are addressed in ASME B31.3 and this Guide.

2 This specification was developed to address the requirements of ASME B31.3 Normal Fluid Service. This specification may be used for Category D fluid services without restrictions. For Category M fluid services, and systems subjected to severe cyclic conditions, additional restrictions apply. These additional restrictions shall be addressed by Engineering.

3 Selections of the different options provided in this specification (e.g., socket-weld vs. buttweld fittings, slip-on vs. weldneck flanges, etc.) will affect the stress levels in the system. Components in an existing system shall be replaced in kind. If components are changed in an existing system, these changes shall be addressed be Engineering. For new system design, specific requirements for options shall be specified on the design drawings.

4 To address the fluid service requirements of a piping system, a corrosion allowance will need to be determined to select the required wall thickness. The fluid service requirements will also affect the selection of materials such as gaskets, valve seats and packing, etc. The corrosion allowance shall be specified by the letter suffix in the piping specification identification (e.g., PS-101A).

5 The minimum test pressures to meet the hydrostatic test limits of the applicable code (i.e. ASME B31.1 or B31.3) are provided in the Design Parameters table in this specification for the listed design pressures and temperatures. Actual system design pressures should be used to establish hydrostatic test pressures for testing. These test pressures are the minimum pressure requirements to be achieved throughout the piping system, adjustments may be required to account for elevation changes in the piping system. The maximum test pressure provided in the design parameters is the lowest pressure at which the pipe size/schedule combination reaches its yield stress. These pressures shall not be exceeded at any location in the piping system. Valves, instruments, fittings and other components may have additional pressure limitations and may require isolation from the test pressure.

6 Additional analysis is required to increase the external pressure rating.

7 Components not provided in the specification can be selected from the standards listed in Table 326.1 of ASME B31.3. Components used in piping systems that are not listed in this table are considered unlisted by the Code and require additional qualification. See ASME B31.3 paragraph 304.7.2. All components must meet the temperature/pressure requirements.

8 The minimum design temperature may be limited by the need for impact testing of material and the qualification of the welding procedure. The temperature limits of the fasteners may also control the minimum design temperature.

9 Components with higher pressure ratings (e.g., thicker pipe or higher rated fittings and flanges) may be used without additional analysis. If such components are mixed within system, additional weld prep to match diameters may be required. All changes shall be documented on design drawings.

10 Appendix E provides guidelines for the installation of fasteners and the selection of alternate fasteners. Studs are the recommended fasteners for connecting flanges in piping systems.

11 Branch connections shall be made with Tees for full size and one size smaller branches, and for all run sizes NPS 2 and smaller. Welded branch connections are otherwise permitted, and shall be reinforced as required (see Appendix N).

12 3D bends are permitted for pipe sizes up to NPS 6.

13 Bends are not permitted for this piping specification.

14 5D bends are permitted up to NPS 6.

15 5D bends are permissible up to NPS 2.5.

16 Piping with high corrosion rates or subject to IGSCC may require the use of corrosion-evaluated materials. When corrosion evaluation is required, this specification shall be identified as PS-number (A,B,C,D)-CE (e.g. PS-200A-CE).

17 Tubing purchased to ASTM A269 shall require that CMTRs must specify mechanical testing to comply with ASME B31.3.

18 Welded fittings are to be of L-Grade material only.

19 Flange material and pressure/temperature rating shall be selected based on ASME B16.5 and the actual system design pressure and temperature.

20 This specification was developed to address the requirements of ASME B31.3 Category D Fluid Service. This specification is not to be used for other fluid service categories

21 Type K tubing may be substituted for Type L tubing.

22 When hardened temper copper tubing (e.g., H temper) is used, the tubing shall be annealed before bending or flaring.

23 Soldering or brazing is allowed with this tubing specification. Soldered joints shall be made with 95-5 Tin-Antimony solder.

24 Qualification of the Copper Tubing in this P-Spec is based on properties of annealed material.

25 This specification was developed to address the requirements of ASME B31.3 Normal Fluid Service, and may not be used in Category M fluid service

26 Brazing of the joints is required with this tubing specification. The use of soft solder is not permitted.

27 ASME B16.15, B16.18, and B16.22 fittings should be ordered 1/8 inch less than the tube O.D. when used with ASTM B280 tubing.

28 Branch connections shall be made with fittings in all sizes.

29 Piping in all Fluid Services except Category D shall be safeguarded per ASME B31.3.

30 Ultraviolet inhibitor shall be specified if piping is to be used above ground.

31 SDR Rated pipe per ASTM F442 is acceptable and shall be SDR 26 or lower. This pipe shall not be threaded.

32 Pressure ratings for 100° F may be determined be multiplying the above design pressures be 0.625. For example, DR 9 pipe would be rated at 125 psig at 100° F (200 psig times 0.625 = 125 psig).

33 This pipe and tube is ordered based on pressure rated diameter to thickness ratios (DR). To address the different Dimension Ratios (DRs) identified in this piping specification, the appropriate letter suffix shall be specified to identify which DR is required (e.g. PS-502F). The DRs to which the letter suffixes correspond is identified in the Design Parameters section of the specification and the Required DR Schedules are also listed in the specification.

34 This piping specification provides the required information to meet the pressure design requirements of ASME B31.1 piping code. Additional requirements include, but are not limited to, support design, thermal expansion, material selection, examination, and testing. These additional requirements are addressed in ASME B31.1 and this Guide.

35 This piping specification was developed to address the requirements of ASME B31.1 Non Boiler External Piping. This specification may not be used for Boiler External Piping without additional restrictions.

36 Piping components not provided in this piping specification can be selected from the standards listed in Table 126.1 of ASME B31.1. Components used in piping systems that are not listed in this table are considered unlisted by the Code and require additional qualification. See ASME B31.1 paragraph 104.7.2. All components must meet the temperature/pressure requirements of the system.

37 The minimum test pressures to meet the hydrostatic test limits of ASME B31.1 are provided in the Design Parameters table in each specification for the listed design pressures and temperatures. Actual system design pressures should be used to establish hydrostatic test pressures for testing. These test pressures are the minimum pressure requirements to be achieved throughout the piping system, adjustments may be required to account for elevation changes in the piping system. The maximum test pressure provided in the schedule tables of the specification represent the pressure where the piping reaches its yield stress. These pressures shall not be exceeded at any location in the piping system. Valves, instruments, fittings and other components may have additional pressure limitations and may require isolation from the test pressure.

38 Where steel pipe is threaded and used for steam service above 250 psi or for water service above 100 psi with water temperatures above 220° F, the pipe shall be seamless and have a thickness at least equal to schedule 80 of ASME B36.10.

39 Consult engineering for selection of fasteners in fluid services above 600° F.

40 This piping specification provides the required information to meet the pressure design requirements of the AWWA piping. Additional requirements include, but are not limited to, support design, thermal expansion, material selection, examination, and testing. These additional requirements are addressed in AWWA Manual M23 "PVC Pipe – Design and Installation."

41 This piping specification was NOT developed to address the requirements of ASME B31.3. This specification may be used for ASME B31.3 service only when the additional requirements of ASME B31.3 are addressed and implemented.

42 The minimum test pressures to meet the hydrostatic test limits of AWWA M23 are provided in the Design Parameters table in each specification for the listed design pressures and temperatures. Actual system design pressures should be used to establish hydrostatic test pressures for testing. These test pressures are the minimum pressure requirements to be achieved at the source of pressurization. When accounting for elevation, the high point of the system must be subjected to at least 188 psi. The maximum test pressure provided in the schedule table of the specification represents a 10% increase above the minimum. These pressures shall not be exceeded at any location in the piping system. Valves, instruments, fittings and other components may have additional pressure limitations and may require isolation for the test pressure.

43 Installation, examination and testing shall be per AWWA M23.

44 Piping components not provided in this piping specification can be selected from the appropriate standards that meet the design requirements of AWWA. Components used in piping systems that are not listed in this table are considered unlisted be the Code and require additional qualification.

45 Cast Iron mechanical joint fittings can damage PVC pipe if over tightened. Consult pipe manufacturer for guidance concerning installation of these fitting.

46 This piping specification provides the required information to meet the pressure design requirements of the AWWA piping. Additional requirements include, but are not limited to, support design, thermal expansion, material selection, examination, and testing. These additional requirements are addressed in AWWA C600 "Installation of Ductile Iron Water Mains and Their Appurtenances". Additionally, the required thickness of ductile iron pipe is dependent on the laying conditions for buried pipe. This should be verified by Design prior to specification of the pipe, and is addressed in AWWA C150 "Thickness Design of Ductile Iron Pipe".

47 The minimum test pressures to meet the hydrostatic test limits of AWWA C600 are provided in the Design Parameters table for the listed design pressures and temperatures. Actual system design pressures should be used to establish hydrostatic test pressures. These test pressures are the minimum pressure requirements to be achieved at the source of pressurization. When accounting for elevation, the high point of the system must be subjected to at least 313 psi. The maximum test pressure provided in the schedule table on the specification represent a 25 psi increase above the minimum. These pressures shall not be exceeded at any location in the piping system. Valves, instruments, fittings and other components may have additional pressure limitations and may require isolation for the test pressure.

48 Installation, examination and testing shall be per AWWA C600.

49 Cement-mortar lining per AWWA C104/A21.4 is acceptable

50 Flanges and flanged joints identified in this specification have bolt patterns identical to ASME B16.1 Class 125 flanges. However, B16.1 flanges are not rated for the design pressures allowed herein.

Piping Specification 101	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-101(A, B, C, D)						
Design Pressure (psig)	285	260	230	200	170	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	430	390	345	300	270	245	220
Maximum Test Pressure (psig)	820						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10M	ASTM A53	B	ERW – Type E/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
B	0.031	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
C	0.063	Schedule	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
D	0.125	Schedule	-	XXS	160	160	160	80	80	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.031	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
C	0.063	Schedule	-	80	80	80	80	80	80	80	STD	STD
D	0.125	Schedule	-	XXS	160	160	160	160	160	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#, 3000#	ASME B16.11	ASTM A105	WP	Use 3000# for PS101-D
Socket-Weld Fittings	¼ - 2	3000#, 6000#	ASME B16.11	ASTM A105	WP	Use 6000# for PS101-D
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 102	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-102(A, B, C, D)						
Design Pressure (psig)	285	260	225	185	-	-	-
Design Temperature (°F)	100	200	250	300	-	-	-
Minimum Temperature (°F)	-20	-20	-20	-20	-	-	-
Minimum Test Pressure (psig)	430	390	340	280	-	-	-
Maximum Test Pressure (psig)	820						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 150 per B16.3
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	ERW/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
B	0.031	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
C	0.062	Schedule	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
D	0.125	Schedule	-	-	160	160	160	80	80	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.031	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
C	0.063	Schedule	-	80	80	80	80	80	80	80	STD	STD
D	0.125	Schedule	-	-	160	160	160	160	160	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#, 3000#	ASME B16.11	ASTM A105	WP	Use 3000# for PS102-D
Threaded Fittings	¼ - 6	Class 150	ASME B16.3	ASTM A197	N/A	Malleable Iron, Not allowed in PS102- D
Threaded Fittings	¼ - 4	Class 150	ASME B16.39	ASTM A197	N/A	Malleable Iron, Not allowed in PS102-D
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WP	Not allowed in PS102-D
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	Limited to 2" and larger is PS102-D
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	Not allowed in PS102-D
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 103 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	**PS-103 (A, B, C, D)**						
Design Pressure (psig)	740	675	655	635	600	550	535
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	1110	1015	985	955	950	955	945
Maximum Test Pressure (psig)	1320						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	Welded/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	40	XS	40	40
B	0.031	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	40	40	XS	40	40
C	0.063	Schedule	80	80	80	STD	80	80	STD	STD	STD	80	STD	STD	40	40	40	40	40	40
D	0.125	Schedule	-	-	160	160	160	160	80	80	80	80	80	80	XS	XS	80	80	80	80

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.031	Schedule	80	80	80	80	80	80	80	80	80	80
C	0.063	Schedule	-	160	160	160	80	80	80	80	80	80
D	0.125	Schedule	-	-	-	-	160	160	160	160	120	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A105	WP	
Socket-Weld Fittings	¼ - 2	3000#, 6000#	ASME B16.11	ASTM A105	WP	Use 6000# in PS103-D
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 300	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 300	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 300	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 300	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 300	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 300	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	Min. Temp. = 50°F, See General Note 10
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 104 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-104(A, B, C, D)						
Design Pressure (psig)	990	900	875	845	800	730	715
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	1485	1355	1315	1270	1270	1265	1260
Maximum Test Pressure (psig)	1775						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 400
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	Welded/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	XS	XS	80	80	80	80
B	0.03	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	80	STD	80	XS	XS	80	80	80	80
C	0.05	Schedule	80	80	80	80	80	80	80	80	80	80	80	80	XS	80	80	80	80	80
D	0.07	Schedule	-	-	-	160	160	160	160	160	120	120	80	80	80	80	80	80	80	80

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	80	80	80	80	80	80	80	80	80	80
B	0.03	Schedule	80	80	80	80	80	80	80	80	80	80
C	0.05	Schedule	-	160	160	160	160	160	160	160	80	80
D	0.07	Schedule	-	-	-	-	-	160	160	160	120	120

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#, 3000#	ASME B16.11	ASTM A105	WP	2000# only where pipe is ≤ Sch. 80
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 400/600	ASME B16.5	ASTM A105	N/A	Class 600 required for sizes ½ - 3
Socket-Weld Flange	½ - 2	Class 600	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 400/600	ASME B16.5	ASTM A105	N/A	Class 600 required for sizes ½ - 3
Slip-on Flange	½ - 24	Class 400/600	ASME B16.5	ASTM A105	N/A	Class 600 required for sizes ½ - 3
Blind Flange	½ - 24	Class 400/600	ASME B16.5	ASTM A105	N/A	Class 600 required for sizes ½ - 3
Backup Flange	½ - 24	Class 400/600	ASME B16.5	ASTM A105	N/A	Class 600 required for sizes ½ - 3

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅞	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10
Nuts	½ - 1 ⅞	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 105 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-105(A, B, C, D)						
Design Pressure (psig)	1480	1350	1315	1270	1200	1095	1075
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	2220	2025	1975	1905	1905	1900	1900
Maximum Test Pressure (psig)	2625						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 600
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	Welded/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	80	80	80	80	80	80	80	80	80	80
B	0.030	Schedule	STD	STD	STD	STD	80	80	80	80	80	120	80	80	80	80	80	80	80	80
C	0.050	Schedule	80	80	80	80	80	80	80	80	120	120	80	80	80	80	80	80	80	80
D	0.070	Schedule	-	160	160	160	160	160	160	160	120	120	80	120	120	120	120	120	120	120

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	80	80	80	80	120
B	0.030	Schedule	80	80	80	80	160	160	160	160	120	120
C	0.050	Schedule	-	160	160	160	160	160	160	160	120	120
D	0.070	Schedule	-	160	160	160	160	160	160	160	120	120

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#, 3000#	ASME B16.11	ASTM A105	WP	2000# only where pipe is ≤ Sch. 80
Socket-Weld Fittings	¼ - 2	3000#, 6000#	ASME B16.11	ASTM A105	WP	3000# only where pipe is ≤ Sch. 80
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 600	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 600	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 600	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 600	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 600	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 600	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅞	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10
Nuts	½ - 1 ⅞	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 106 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-106(A, B, C, D)						
Design Pressure (psig)	1000	855	815	645	120	75	50
Design Temperature (°F)	400	600	700	750	1000	1050	1100
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	1500	1485	1480	1490	1170	730	490
Maximum Test Pressure (psig)	1790						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	1000 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A53	B	Seamless
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
B	0.030	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
C	0.050	Schedule	80	STD	STD	STD	STD	80	STD	STD	STD	80

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	80	80
B	0.030	Schedule	80	80	80	80	80	80	80	80	80	80
C	0.050	Schedule	-	80	80	80	80	80	80	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A105	WP	Only for fit up to threaded components
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	½ - 6	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 6	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 6	Class 600	ASME B16.5	ASTM A105	N/A	limited to 1000°F
Weldneck Flange	½ - 6	Class 600	ASME B16.5	ASTM A105	N/A	limited to 1000°F
Slip-on Flange	½ - 6	Class 600	ASME B16.5	ASTM A105	N/A	limited to 1000°F
Backup Flange	½ - 6	Class 600	ASME B16.5	ASTM A105	N/A	limited to 1000°F

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 107 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-107(A, B)						
Design Pressure (psig)	3705	3375	3280	3170	2995	2735	2665
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	5560	5065	4920	4755	4755	4745	4845
Maximum Test Pressure (psig)	6505						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 1500
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A53	B	Seamless
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	STD	STD	80	80	160	160	160	160	XXS	XXS
B	0.030	Schedule	80	160	160	160	XXS	160	XXS	XXS	XXS	-

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	9000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	¼ - 6	see schedule table	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	¼ - 6	see schedule table	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 1500	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 6	Class 1500	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 6	Class 1500	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅜	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10
Nuts	½ - 1 ⅜	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 108	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-108						
Design Pressure (psig)	6170	5625	5470	5280	4990	4560	4440
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	9255	8440	8205	7920	7920	7910	8075
Maximum Test Pressure (psig)	11,295						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 2500
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 15.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 3	Schedule Tables	ASME B36.10	ASTM A53	B	Seamless
Piping	¼ - 3	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3
108	0.000	Schedule	80	160	160	160	XXS	XXS	XXS	XXS

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	9000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	½ - 3	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 3	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Weldneck Flange	½ - 3	Class 2500	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	¾ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10
Nuts	¾ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 109 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-109(A, B, C, D)	
Design Pressure (psig)	500	500
Design Temperature (°F)	100	200
Minimum Temperature (°F)	-20	-20
Minimum Test Pressure (psig)	750	750
Maximum Test Pressure (psig)	1810	

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	500 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12. and 51

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 10	Schedule Tables	ASME B36.10M	ASTM A53	B	ERW – Type E/Seamless
Piping	¼ - 10	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10
A	0.000	Schedule	40	40	40	40	40	40	40	40	40	40	40	40
B	0.031	Schedule	40	40	40	40	40	40	40	40	40	40	40	40
C	0.063	Schedule	80	80	80	40	40	40	40	40	40	40	40	40

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	40	40	40	40	40
B	0.031	Schedule	80	80	80	80	80	80	80	80	80	80
C	0.063	Schedule	-	160	160	160	80	80	80	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Victaulic Zero-Flex Coupling 07	1 - 10	Manufacturer's	Manufacturer's	Manufacturer's	Manufacturer's	Use with EPDM gasket, Min Temp 20° F.
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A105	WP	
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	½ - 10	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 10	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flanges	½ - 6	Class 300	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 300	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ – 10	Class 300	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ – 10	Class 300	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ – 10	Class 300	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ – 10	Class 300	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10. Not for use with Victaulic Fittings
Nuts	½ - 1	ASME B18.2.2	ASTM A194	2H-HH	Not for use with Victaulic Fittings

Piping Specification 200	Date: September 17, 2014	Revision: 0	Page 1 of 1

DESIGN PARAMETERS

P-Spec	PS-200(A, B, C, D)						
Design Pressure (psig)	230	195	175	160	145	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	345	295	265	255	245	250	230
Maximum Test Pressure (psig)	440 for NPS ≤ 6, 360 for NPS > 6						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

GENERAL NOTES

Refer to General Notes 1-12, 16.

ALLOWABLE PIPE MATERIALS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Welded
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Seamless

REQUIRED SCHEDULES FOR NON-THREADED PIPE

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	-	-	-	-
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	40S	40S	10S	10S	40S	-	-	-	-	-
D	0.08	Schedule	-	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

REQUIRED SCHEDULES FOR THREADED PIPE

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S
D	0.08	Schedule	-	-	-	-	80S	80S	80S	80S	80S	40S

FITTINGS

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F304L	
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

FLANGES

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A182	F304L	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. Note 69. See note 8
Backup Flange	½ - 24	Class 150	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F, Max. Temp. 650°F See note 8.

MECHANICAL FASTENERS

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 201	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-201(A, B, C, D)						
Design Pressure (psig)	230	195	175	160	145	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	345	295	265	255	250	255	230
Maximum Test Pressure (psig)	440 for NPS ≤ 6, 360 for NPS > 6						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Welded
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	-	-	-	-
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	40S	40S	10S	10S	40S	-	-	-	-	-
D	0.08	Schedule	-	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S
D	0.08	Schedule	-	-	-	80S	80S	80S	80S	80S	80S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F316L	
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F316L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A403	WP316L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A403	WP316L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A182	F316L	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A182	F316L	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F316L	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F316L	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F316L	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. See note 8
Backup Flange	½ - 24	Class 150	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F, Max. Temp. 650°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 202	Date: September 17, 2014	Revision: 0	Page 1 of 2

Design Parameters

P-Spec	PS-202(A, B, C, D)						
Design Pressure (psig)	600	505	455	415	380	360	350
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	760	680	660	645	645	640
Maximum Test Pressure (psig)	935						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Welded
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	80S	40S	40S	80S
D	0.08	Schedule	-	80S	80S	80S	80S	80S	80S	80S	80S	80S	40S	40S	80S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	80S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S
C	0.05	Schedule	-	80S	80S	80S	80S	80S	80S	80S	80S	80S
D	0.08	Schedule	-	-	-	-	-	-	-	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F304L	
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A132	F304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 300	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F304L	
Blind Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F304L	
Threaded Flange	½ - 6	Class 300	ASME B16.5	ASTM A182	F304L	
Backup Flange	½ - 12	Class 300	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F, See note 8
Backup Flange	½ - 12	Class 300	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F, Max. Temp. 650°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅛	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ⅛	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 203 Date: September 17, 2014 Revision: 0 Page 1 of 2

Design Parameters

P-Spec	**PS-203(A, B, C, D)**						
Design Pressure (psig)	600	505	455	415	380	360	350
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	760	680	670	660	670	665
Maximum Test Pressure (psig)	935						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	316L	Welded
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	316L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	80S	40S	40S	80S
D	0.08	Schedule	-	80S	80S	80S	80S	80S	80S	80S	80S	80S	40S	40S	80S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	80S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S
C	0.05	Schedule	-	80S	80S	80S	80S	80S	80S	80S	80S	80S
D	0.08	Schedule	-	-	-	-	-	-	-	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F316L	
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F316L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	ASTM A403	WP316L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	ASTM A403	WP316L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F316L	
Weldneck Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F316L	
Slip-on Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F316L	
Blind Flange	½ - 12	Class 300	ASME B16.5	ASTM A182	F316L	
Threaded Flange	½ - 6	Class 300	ASME B16.5	ASTM A182	F316L	
Backup Flange	½ - 12	Class 300	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. See note 8
Backup Flange	½ - 12	Class 300	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F, Max. Temp. 650°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅛	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ⅛	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 204	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-204(A, B)						
Design Pressure (psig)	600	600	565	500	465	425	280
Design Temperature (°F)	100	300	400	600	800	900	1000
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	900	895	895	895	895	900
Maximum Test Pressure (psig)	1705						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 -2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	600 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 16-18.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	1/16 - 2	Schedule Tables	ASME A269	ASME A269	304L	
Tubing	1/16 - 2	Schedule Tables	ASME A249	ASME A249	304L	

Required Thickness for Tube in Gas Service:

P-Spec	Corrosion Allowance	Pipe Size	1/8	3/16	¼	5/16	3/8	½	5/8	¾	7/8	1	1 ¼	1 ½	2
A	0.00	Thickness	0.028	0.028	0.028	0.035	0.035	0.041	0.052	0.062	0.073	0.083	0.104	0.125	0.167
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D
B	0.01	Thickness	0.028	0.028	0.028	0.035	0.035	0.049	0.052	0.062	0.073	0.083	0.104	0.125	0.167
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D

Required Thickness for Tube in All Other Services:

P-Spec	Corrosion Allowance	Pipe Size	1/16	1/8	3/16	¼	5/16	3/8	½	5/8	¾	7/8	1	1 ¼	1 ½	2
A	0.00	Thickness	0.010	0.028	0.028	0.035	0.035	0.035	0.049	0.049	0.049	0.065	0.065	0.083	0.095	0.109
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D
B	0.01	Thickness	0.020	0.028	0.028	0.035	0.035	0.035	0.049	0.049	0.049	0.065	0.065	0.083	0.095	0.109
Bend Radius			3D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tube Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker
Welded Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker

Piping Specification 205 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-205(A, B)						
Design Pressure (psig)	2000	2000	1890	1675	1555	1425	930
Design Temperature (°F)	100	300	400	600	800	900	1000
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	3000	3000	3000	3000	3000	3000	2990
Maximum Test Pressure (psig)	3920						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	2000 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 16-18.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	1/16 - 2	Schedule Tables	ASTM A269	ASTM A269	TP 304L	
Tubing	1/16 - 2	Schedule Tables	ASTM A249	ASTM A249	TP 304L	

Required Thickness for Tube

P-Spec	Corrosion Allowance	Pipe Size	1/16	1/8	3/16	¼	5/16	3/8	½	5/8	¾	7/8	1	1 ¼	1 ½	2
A	0.00	Thickness	0.014	0.028	0.028	0.035	0.049	0.049	0.065	0.083	0.095	0.095	0.109	0.109	0.120	0.188
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	3D	3D	3D	3D	3D
B	0.01	Thickness	0.020	0.035	0.049	0.049	0.065	0.065	0.083	0.095	0.095	0.095	0.120	0.156	0.188	0.188
Bend Radius			5D	3D	3D	3D	3D	3D	3D	3D	3D	5D	3D	3D	3D	5D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tube Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker
Welded Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker

Piping Specification 206	Date: September 17, 2014	Revision: 0	Page 1 of 1

DESIGN PARAMETERS

P-Spec	**PS-206(A, B)**						
Design Pressure (psig)	600	600	565	500	465	425	280
Design Temperature (°F)	100	300	400	600	800	900	1000
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	900	915	930	940	900	625
Maximum Test Pressure (psig)	1780						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	600 psi
External Pressure Rating:	15 psi

GENERAL NOTES

Refer to General Notes 1-9, 16-18.

ALLOWABLE TUBE MATERIALS

Component	**Size**	**Rating**	**Standard**	**Material**	**Material Grade**	**Additional Requirements**
Tubing	1/16 - 2	Schedule Tables	ASTM A269	ASTM A269	TP 316L	
Tubing	1/16 - 2	Schedule Tables	ASTM A249	ASTM A249	TP 316L	

REQUIRED THICKNESS FOR TUBE IN GAS SERVICE:

P-Spec	**Corrosion Allowance**	**Pipe Size**	**1/8**	**3/16**	**¼**	**5/16**	**3/8**	**½**	**5/8**	**¾**	**7/8**	**1**	**1 ¼**	**1 ½**	**2**
A	0.00	Thickness	0.028	0.028	0.028	0.035	0.035	0.041	0.052	0.062	0.073	0.083	0.104	0.125	0.167
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D
B	0.01	Thickness	0.028	0.028	0.028	0.035	0.035	0.049	0.052	0.062	0.073	0.083	0.104	0.125	0.167
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D

REQUIRED THICKNESS FOR TUBE IN ALL OTHER SERVICES:

P-Spec	**Corrosion Allowance**	**Pipe Size**	**1/16**	**1/8**	**3/16**	**¼**	**5/16**	**3/8**	**½**	**5/8**	**¾**	**7/8**	**1**	**1 ¼**	**1 ½**	**2**
A	0.00	Thickness	0.010	0.028	0.028	0.028	0.035	0.035	0.035	0.049	0.049	0.049	0.065	0.095	0.095	0.109
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D
B	0.01	Thickness	0.020	0.028	0.028	0.035	0.035	0.035	0.049	0.049	0.049	0.065	0.065	0.095	0.095	0.109
Bend Radius			3D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D

FITTINGS

Component	**Size**	**Rating**	**Standard**	**Material**	**Material Grade**	**Additional Requirements**
Tube Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker
Welded Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker

Piping Specification 207	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-207(A, B)						
Design Pressure (psig)	2000	2000	1890	1675	1555	1425	930
Design Temperature (°F)	100	300	400	600	800	900	1000
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	3000	3000	3055	3110	3140	3025	2080
Maximum Test Pressure (psig)	3330						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	2000 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 16-18.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	1/16 - 2	Schedule Tables	ASTM A269	ASTM A269	TP 316L	
Tubing	1/16 - 2	Schedule Tables	ASTM A249	ASTM A249	TP 316L	

Required Thickness for Tube

P-Spec	Corrosion Allowance	Pipe Size	1/16	1/8	3/16	¼	5/16	3/8	½	5/8	¾	7/8	1	1 ¼	1 ½	2
A	0.00	Thickness	0.010	0.028	0.028	0.035	0.083	0.049	0.083	0.083	0.095	0.095	0.120	0.156	0.188	0.188
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	3D	3D	3D	3D	5D
B	0.01	Thickness	0.020	0.035	0.049	0.065	0.065	0.065	0.083	0.095	0.095	0.095	0.120	0.156	0.188	0.188
Bend Radius			5D	1.5D	1.5D	1.5D	1.5D	3D	3D	3D	3D	5D	3D	3D	3D	-

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tube Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker
Welded Fittings	1/16 - 2	Manufacturer's	Manufacturer's	ASTM A182/A479	316L/304L	Swagelok/Cajon or Parker

Piping Specification 208	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-208(A, B, C)						
Design Pressure (psig)	800	675	605	550	510	480	460
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	1200	1015	910	875	865	860	855
Maximum Test Pressure (psig)	1215						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 400
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16-18.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Welded
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	40S	40S	40S	80S	40S	40S	80S
B	0.03	Schedule	40S	10S	40S	10S	40S	40S	40S	40S	40S	80S	80S	80S	80S
C	0.05	Schedule	80S	40S	80S	40S	80S	80S	40S	80S	80S	80S	80S	80S	80S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	80S	80S	80S	80S	80S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S
C	0.05	Schedule	-	-	-	-	-	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F304/F304L	
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 600	ASME B16.5	ASTM A182	F304L	Use Class 600 for NPS greater than 3
Threaded Flanges	½ -6	Class 400, 600	ASME B16.5	ASTM A182	F304L	Use Class 600 for NPS greater than 3
Weldneck Flange	½ - 12	Class 400, 600	ASME B16.5	ASTM A182	F304L	Use Class 600 for NPS greater than 3
Slip-on Flange	½ - 12	Class 400, 600	ASME B16.5	ASTM A182	F304L	Use Class 600 for NPS greater than 3
Blind Flange	½ - 12	Class 400, 600	ASME B16.5	ASTM A182	F304L	Use Class 600 for NPS greater than 3
Backup Flange	½ - 12	Class 400, 600	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. Use Class 600 for NPS greater than 3. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 209	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-209(A, B, C)						
Design Pressure (psig)	1200	1015	910	825	765	720	685
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	1800	1525	1365	1310	1295	1290	1270
Maximum Test Pressure (psig)	1845						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 600
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 8	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Welded
Piping	¼ - 8	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8
A	0.00	Schedule	10S	10S	10S	10S	40S	40S	40S	80S	80S	80S	80S
B	0.03	Schedule	40S	40S	40S	40S	80S	80S	80S	80S	80S	-	80S
C	0.05	Schedule	80S	80S	80S	80S	80S	-	80S	80S	-	-	80S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3
A	0.00	Schedule	40S	40S	80S	80S	80S	80S	80S	80S
B	0.03	Schedule	80S	80S	80S	80S	-	-	-	-
C	0.05	Schedule	-	-	-	-	-	-	-	-

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 3	2000#	ASME B16.11	ASTM A182	F304/F304L	
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	½ - 8	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 8	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 600	ASME B16.5	ASTM A182	F304L	
Threaded Flanges	½ - 3	Class 600	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 8	Class 600	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 8	Class 600	ASME B16.5	ASTM A182	F304L	
Blind Flange	½ - 8	Class 600	ASME B16.5	ASTM A182	F304L	
Backup Flange	½ - 8	Class 600	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅛	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10
Nuts	½ - 1 ⅛	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 210	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-210(A, B)						
Design Pressure (psig)	600	480	445	405	260	125	35
Design Temperature (°F)	300	500	800	900	1000	1150	1400
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	815	860	855	835	785	340
Maximum Test Pressure (psig)	935						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	600 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16, 19.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F304/F304L	Only for fit up to threaded components
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	See note 19	ASME B16.5	ASTM A182	See note 19	
Threaded Flange	½ - 6	See note 19	ASME B16.5	ASTM A182	See note 19	
Weldneck Flange	½ - 8	See note 19	ASME B16.5	ASTM A182	See note 19	
Slip-on Flange	½ - 8	See note 19	ASME B16.5	ASTM A182	See note 19	
Blind Flange	½ - 8	See note 19	ASME B16.5	ASTM A182	See note 19	
Backup Flange	½ - 8	See note 19	ASME B16.5	ASTM A105	N/A	See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	B16.5	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Limited to 1000°F, See note 10
Nuts	B16.5	ASME B18.2.2	ASTM A194	8F-HH	Limited to 1000°F

Piping Specification 211	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-211(A, B)						
Design Pressure (psig)	600	480	445	405	260	125	35
Design Temperature (°F)	300	500	800	900	1000	1150	1400
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	900	835	900	860	585	355	340
Maximum Test Pressure (psig)	935						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	600 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16, 19.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B36.19	ASTM A312	TP 316L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F316/F316L	Only for fit up to threaded components
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F316L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	ASTM A403	WP316L	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	ASTM A403	WP316L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	See note 19	ASME B16.5	ASTM A182	See note 19	
Threaded Flanges	½ - 6	See note 19	ASME B16.5	ASTM A182	See note 19	
Weldneck Flange	½ - 12	See note 19	ASME B16.5	ASTM A182	See note 19	
Slip-on Flange	½ - 12	See note 19	ASME B16.5	ASTM A182	See note 19	
Blind Flange	½ - 12	See note 19	ASME B16.5	ASTM A182	See note 19	
Backup Flange	½ - 12	See note 19	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅝	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Limited to 1000°F, See General Note 10.
Nuts	½ - ⅝	ASME B18.2.2	ASTM A194	8F-HH	Limited to 1000°F

Piping Specification 212	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-212(A, B)						
Design Pressure (psig)	1225	1155	1080	1020	950	870	570
Design Temperature (°F)	300	400	500	600	800	900	1000
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	1840	1835	1830	1825	1835	1835	1835
Maximum Test Pressure (psig)	1870						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	1225 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 10	Schedule Tables	ASME B36.19	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10
A	0.00	Schedule	10S	10S	10S	10S	10S	40S	40S	40S	40S	80S	80S	80S
B	0.03	Schedule	40S	40S	40S	40S	40S	80S	40S	80S	80S	80S	80S	80S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	80S	80S	80S	80S	80S	80S	80S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A182	F304L	Only for fit up to threaded components
Buttweld Fittings	½ - 10	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 10	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Weldneck Flange	½ - 10	Class 900, 1500	ASME B16.5	ASTM A182	F304L	Limited to 800°F. Use 1500 for NPS < 3
Slip-on Flange	½ - 10	Class 900, 1500	ASME B16.5	ASTM A182	F304L	Limited to 800°F. Use 1500 for NPS < 3
Threaded Flange	½ - 10	Class 900, 1500	ASME B16.5	ASTM A182	F304L	Limited to 800°F. Use 1500 for NPS < 3
Backup Flange	½ - 4	See note 19	ASME B16.5	ASTM A105	F304L	Limited to 800°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	B16.5	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Limited to 1000°F, See General Note 10.
Nuts	B16.5	ASME B18.2.2	ASTM A194	8F-HH	Limited to 1000°F

Piping Specification 213	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-213(A, B)						
Design Pressure (psig)	3000	2530	2270	2065	1910	1800	1715
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	4500	3795	3405	3275	3235	3220	3180
Maximum Test Pressure (psig)	4530						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 1500
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 14, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40	40	40	80	160	160	160	160	160	160
B	0.03	Schedule	80	80	80	160	160	160	160	160	160	XXS

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	6000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	¼ - 6	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	¼ - 6	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 1500	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 6	Class 1500	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 6	Class 1500	ASME B16.5	ASTM A182	F304L	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	¾ - 1 ⅜	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Limited to 1000°F, See General Note 10.
Nuts	¾ - 1 ⅜	ASME B18.2.2	ASTM A194	8F-HH	Limited to 1000°F

Piping Specification 214	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-214(A, B)						
Design Pressure (psig)	5000	4220	3780	3440	3180	3000	2860
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	7500	6330	5670	5455	5380	5370	5310
Maximum Test Pressure (psig)	7645						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 2500
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-11, 14, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 6	Schedule Tables	ASME B36.10	ASTM A312	TP 304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3
A	0.00	Schedule	80	80	160	160	XXS	XXS	XXS	XXS
B	0.03	Schedule	-	160	160	XXS	XXS	-	XXS	XXS

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	9000#	ASME B16.11	ASTM A182	F304L	
Buttweld Fittings	¼ - 3	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	¼ - 3	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ - 2	Class 2500	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 3	Class 2500	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 3	Class 2500	ASME B16.5	ASTM A182	F304L	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	¾ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	See note 10.
Nuts	¾ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 215 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-215(A, B, C)	
Design Pressure (psig)	230	195
Design Temperature (°F)	100	200
Minimum Temperature (°F)	-425	-425
Minimum Test Pressure (psig)	345	295
Maximum Test Pressure (psig)	365	

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Stainless Steel (316L)
Pressure Rating:	230 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 10	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Welded
Piping	¼ - 10	Schedule Tables	ASME B36.19	ASTM A312	TP316L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	10S	10S	10S	10S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A182	F316L	
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASRM A182	F316L	
Buttweld Fittings	½ – 10	Schedule Tables	ASME B16.9	ASTM A403	WP316L	
Buttweld Fittings	½ - 10	Schedule Tables	ASME B16.28	ASTM A403	WP316L	
Victaulic Zero-Flex Coupling 07	1 - 10	Manufacturer's	Manufacturer's	Manufacturer's	Manufacturer's	Use with EPDM gaskets, Min Temp -20°F.

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket-Weld Flange	½ – 2	Class 150	ASME B16.5	ASTM A182	F316L	
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A182	F316L	
Weldneck Flange	½ - 10	Class 150	ASME B16.5	ASTM A182	F316L	
Slip-on Flange	½ – 10	Class 150	ASME B16.5	ASTM A182	F316L	
Blind Flange	½ - 10	Class 150	ASME B16.5	ASTM A182	F316L	
Backup Flange	½ - 10	Class 150	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. See note 8
Backup Flange	½ - 10	Class 150	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F, Max. Temp. 650°F. See note 8

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners		ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, See Note 10. Not for use with Victaulic Fittings
Nuts		ASME B18.2.2	ASTM A194	8F-HH	Not for use with Victaulic Fittings

Piping Specification 300 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-300(A, B, C, D)						
Design Pressure (psig)	230	195	175	160	145	140	110
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	345	295	265	240	220	225	190
Maximum Test Pressure (psig)	520						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Hastelloy C276
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B619	N10276	Class I or II	Welded
Piping	¼ - 24	Schedule Tables	ASME B622	N10276	N/A	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
C	0.05	Schedule	40S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
D	0.095	Schedule	-	80S	80S	80S	80S	80S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	40S	40S	40S	40S	40S
D	0.095	Schedule	-	-	-	-	80S	80S	80S	80S	80S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	B574/B622	N10276	Engineering approval required.
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	B366	WPHC276	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	B366	WPHC276	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	¼ - 4	Class 150	ASME B16.5	B574/B575	N10276	Engineering approval required
Weldneck Flange	½ - 24	Class 150	ASME B16.5	B574/B575	N10276	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	B574/B575	N10276	Refer to note 5
Blind Flange	½ - 24	Class 150	ASME B16.5	B574/575	N10276	
Backup Flange	½ - 24	Class 150	ASME B16.5	A182/A744	F304/CF-8	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Refer to General Note 10.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 301	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-301(A, B, C, D)						
Design Pressure (psig)	720	600	530	470	435	415	405
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	1080	900	795	705	660	670	690
Maximum Test Pressure (psig)	1225						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Hastelloy C276
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASME B619	N10276	Class I or II	Welded
Piping	¼ - 12	Schedule Tables	ASME B622	N10276	N/A	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	40S	40S	40S	10S	40S	40S	40S	40S	40S	40S	40S	40S	40S
D	0.095	Schedule	-	-	-	80S	80S	80S	80S	80S	80S	80S	40S	40S	40S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S
D	0.095	Schedule	-	-	-	-	-	-	-	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	B574/B622	N10276	Engineering approval required.
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	B366	WPHC276	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	B366	WPHC276	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	¼ - 4	Class 150	ASME B16.5	B574/B575	N10276	Engineering approval required
Weldneck Flange	½ - 12	Class 150	ASME B16.5	B574/B575	N10276	
Slip-on Flange	½ - 12	Class 150	ASME B16.5	B574/B575	N10276	
Blind Flange	½ - 12	Class 150	ASME B16.5	B574/575	N10276	
Backup Flange	½ - 12	Class 150	ASME B16.5	A182/A744	F304/CF-8	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅛	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Refer to General Note 10.
Nuts	½ - 1 ⅛	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 302	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-302(A, B, C, D)						
Design Pressure (psig)	230	215	200	185	170	140	110
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	360	340	325	300	270	230	180
Maximum Test Pressure (psig)	445						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Alloy 20 (N08020)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASTM B464	N08020	N/A	Welded
Piping	¼ - 24	Schedule Tables	ASTM B729	N08020	N/A	Manuf. Hydrostatic Test

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	10S	40S	10S	10S	10S	10S	10S	-	-	-
D	0.07	Schedule	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S
D	0.07	Schedule	-	-	80S	80S	80S	80S	80S	80S	40S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	B462	N08020	Engineering approval required.
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	B366	WP20CB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	B366	WP20CB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	¼ - 4	Class 150	ASME B16.5	B462	N08020	Engineering approval required
Weldneck Flange	½ - 24	Class 150	ASME B16.5	B462	N08020	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	B462	N08020	
Blind Flange	½ - 24	Class 150	ASME B16.5	B462	N08020	
Backup Flange	½ - 24	Class 150	ASME B16.5	A105/A182	N/A/F304	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ⅛	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Refer to General Note 10.
Nuts	½ - 1 ⅛	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 303	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	**PS-303(A, B, C, D)**						
Design Pressure (psig)	600	555	525	480	470	455	445
Design Temperature (°F)	100	200	300	400	500	600	700
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	945	885	850	785	770	745	730
Maximum Test Pressure (psig)	1075						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Alloy 20 (N08020)
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASTM B464	N08020	N/A	Welded
Piping	¼ - 12	Schedule Tables	ASTM B729	N08020	N/A	Manufacturer Hydrostatic Test

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½.	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
D	0.07	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S	40S	40S	40S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	80S
C	0.05	Schedule	-	80S	80S	80S	80S	80S	80S	80S	80S	80S
D	0.07	Schedule	-	-	-	-	80S	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	B462	N08020	Engineering approval required.
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.9	B366	WP20CB	
Buttweld Fittings	½ - 12	Schedule Tables	ASME B16.28	B366	WP20CB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	¼ - 4	Class 300	ASME B16.5	B462	N08020	Engineering approval required
Weldneck Flange	½ - 12	Class 300	ASME B16.5	B462	N08020	
Slip-on Flange	½ - 12	Class 300	ASME B16.5	B462	N08020	
Blind Flange	½ - 12	Class 300	ASME B16.5	B462	N08020	
Backup Flange	½ - 12	Class 300	ASME B16.5	A105/A182	N/A/F304	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ½	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Refer to General Note 10.
Nuts	½ - 1 ½	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 304 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-304(A, B, C, D)						
Design Pressure (psig)	275	260	80	50	35	25	25
Design Temperature (°F)	100	200	800	900	1000	1150	1200
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	415	390	120	95	150	245	245
Maximum Test Pressure (psig)	445						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Inconel 600 (N06600)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 6	Schedule Tables	ASTM B167	N06600	N/A	Seamless, Mnftr Hydro. Test ASTM B517
Piping	¼ - 24	Schedule Tables	ASTM B517	N06600	N/A	Mnftr Hydro. Test ASTM B517

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	10S	10S	10S	10S	10S	-	10S	-
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	10S	40S	10S	10S	10S	10S	-	-	-	-
D	0.07	Schedule	80S	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S
D	0.07	Schedule	-	-	-	80S	80S	80S	80S	80S	40S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	B564	N06600	Engineering approval required
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	B366	WPNCI	Seamless or welded
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	B366	WPNCI	Seamless or welded

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Weldneck Flange	½ - 24	Class 150	ASME B16.5	B564/B168	N06600	Only up to 900°
Blind Flange	½ - 24	Class 150	ASME B16.5	B564/B168	N06600	Only up to 900°
Backup Flange	½ - 24	Class 150	ASME B16.5	A105	N/A	Only up to 900°

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ½	ASME B18.2.1	ASTM A193	B8 C1. 2-HH	Refer to General Note 10.
Nuts	½ - 1 ½	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 305	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-305(A, B, C, D)						
Design Pressure (psig)	290	260	200	140	110	80	65
Design Temperature (°F)	100	200	400	600	700	800	850
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	435	430	365	265	210	150	125
Maximum Test Pressure (psig)	600						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Inconel 690 (N06690)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASTM B167	N06690	N/A	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	40S	40S	40S	40S	40S
C	0.05	Schedule	40S	40S	40S	10S	40S	40S	40S	40S	40S	40S	40S	40S	40S
D	0.07	Schedule	80S	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	80S	80S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	80S	80S	80S	40S
D	0.07	Schedule	-	-	-	-	80S	80S	80S	80S	80S	80S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Buttweld Fittings	½ - 6	Schedule Tables	ASME B16.9	B366	WP***S	Seamless, Alloy N06690 required
Buttweld Fittings	½ - 6	Schedule Tables	ASME B16.28	B366	WP***S	Seamless, Alloy N06690 required.

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Weldneck Flange	½ - 6	Class 150	ASME B16.5	B564/B168	N06690	
Blind Flange	½ - 6	Class 150	ASME B16.5	B564/B168	N06690	
Backup Flange	½ - 6	Class 150	ASME B16.5	A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	ASME B18.2.1	ASTM A193	B8	Refer to General Note 10.
Nuts	½ - ¾	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 306	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-306(A, B, C)						
Design Pressure (psig)	230	200	190	185	170	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-325	-325	-325	-325	-325	-325	-325
Minimum Test Pressure (psig)	360	335	330	320	295	245	225
Maximum Test Pressure (psig)	395						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Monel (N04400)
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12, 16.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 8	Schedule Tables	ASTM B165	N04400	N/A	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	40S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
C	0.05	Schedule	40S	10S	40S	10S	10S	10S	10S	10S	40S	40S	10S

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	40S	40S	40S	40S

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 6	2000#	ASME B16.11	B564	N04400	Engineering approval required
Buttweld Fittings	½ - 8	Schedule Tables	ASME B16.9	B366	WPNC	Seamless or welded
Buttweld Fittings	½ - 8	Schedule Tables	ASME B16.28	B366	WPNC	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Weldneck Flange	½ - 8	Class 150	ASME B16.5	B564/B127	N04400	
Blind Flange	½ - 8	Class 150	ASME B16.5	B564/B127	N04400	
Backup Flange	½ - 8	Class 150	ASME B16.5	A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	ASME B18.2.1	ASTM A193	B8 C1.2-HH	Refer to General Note 10.
Nuts	½ - ¾	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 400	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-400
Design Pressure (psig)	150
Design Temperature (°F)	250
Minimum Temperature (°F)	-20
Minimum Test Pressure (psig)	280
Maximum Test Pressure (psig)	295

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Category D
Material:	Copper
Pressure Rating:	150 psi
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1, 3, 5-10, 20-24.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 4	Type L	ASTM B88	ASTM B88	Temper 050,060,H	Seamless
Tubing	¼ - 4	Type K	ASTM B88	ASTM B88	Temper 050,060,H	Seamless

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4
400	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070	0.080	0.090	0.100	0.110
Bend Radius			3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	3D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 125	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 4	Type L	ASME B16.18	ASTM B62	N/A	
Soldered Fittings	¼ - 4	Type L	ASME B16.22	ASME B16.22	N/A	
Flared Fittings	⅜ - 2	175 psig	ASME B16.26	ASTM B62	N/A	Max Temperature 100°
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 4	Class 150	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 4	Class 150	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅝	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1-HH	Refer to General Note 10.
Nuts	½ - ⅝	N/A	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 401 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-401						
Design Pressure (psig)	225	225	210	195	180	165	130
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	340	400	395	365	345	370	390
Maximum Test Pressure (psig)	410						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	225 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1, 3, 5-10, 21, 22, 24-26.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 4	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless
Tubing	¼ - 4	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4
401	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070	0.080	0.090	0.100	0.110
Bend Radius			3D	3D	3D	3D	3D	3D	3D	3D	3D	3D	5D	5D	-

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 125	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 4	Type L	ASME B16.18	ASTM B62	N/A	
Soldered Fittings	¼ - 4	Type L	ASME B16.22	ASME B16.22	N/A	
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 4	Class 150	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 4	Class 150	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅝	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1-HH	Refer to General Note 10.
Nuts	½ - ⅝	N/A	ASME B18.2.2	ASTM A194	8F-HH	

Piping Specification 402	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-402						
Design Pressure (psig)	355	300	280	280	275	235	175
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	535	530	525	525	525	530	525
Maximum Test Pressure (psig)	560						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	355 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1, 3, 5-10, 21, 22, 24-26.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - 2	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless
Tubing	¼ - 2	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2
402	0.00	Thickness	0.030	0.035	0.040	0.042	0.045	0.050	0.055	0.060	0.070
Bend Radius			3D	3D	3D	3D	3D	3D	5D	5D	-

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 2	Class 250	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 2	Type L	ASME B16.18	ASTM B62	N/A	Brazed
Soldered Fittings	¼ - 2	Type L	ASME B16.22	ASME B16.22	N/A	Brazed
Flared Fittings	¼ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200 °
Tube Fittings	¼ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 2	Class 300	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 2	Class 300	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1- HH	Min temperature - 325°F, See note 10
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A194	8F- HH	

Piping Specification 403	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-403						
Design Pressure (psig)	320	270	255	255	250	210	160
Design Temperature (°F)	100	150	200	250	300	350	400
Minimum Temperature (°F)	-452	-452	-452	-452	-452	-452	-452
Minimum Test Pressure (psig)	480	475	480	480	480	475	480
Maximum Test Pressure (psig)	495						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Copper
Pressure Rating:	400 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1, 3, 5-10, 21, 22, 24-27.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	¼ - ⅝	Type L	ASTM B88	ASTM B88	Temper 050,060, H	Seamless, Clean per ASTM B280
Tubing	¼ - 2	Type K	ASTM B88	ASTM B88	Temper 050,060, H	Seamless, Clean per ASTM B280

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	2
403	0.00	Thickness	0.030	0.035	0.040	0.042	0.065	0.065	0.065	0.072	0.083
Bend Radius			3D	3D	3D	3D	1.5D	3D	3D	3D	5D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 2	Class 250	ASME B16.15	AST B62	N/A	Max Temperature 350°
Soldered Fittings	¼ - 2	Type L	ASME B16.18	ASTM B62	N/A	Brazed
Soldered Fittings	⅛ - 2	Type L	ASME B16.22	ASME B16.22	N/A	Brazed
Flared Fittings	⅛ - 2	500 psig	SAE J513	SAE J513	N/A	With Flare Nuts, Max Temp 200°
Tube Fittings	⅛ - 2	Manufacture's	Manufacturer's	Brass per Manufacturer's	N/A	Swagelok/Cajon/ or Parker

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 2	Class 300	ASME B16.24	ASTM B61	N/A	
Threaded Flanges	½ - 2	Class 300	ASME B16.24	ASTM B62	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1- HH	Min temperature - 325°F, See note 10
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A194	8F- HH	

Piping Specification 404	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-404			
Design Pressure (psig)	275	270	265	260
Design Temperature (°F)	100	150	200	250
Minimum Temperature (°F)	-452	-452	-452	-452
Minimum Test Pressure (psig)	415	405	400	390
Maximum Test Pressure (psig)	445			

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Aluminum (6061/6063)
Pressure Rating:	Class 150
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 12	Schedule Tables	ASTM B241	ASTM B241	6061-T6	Seamless
Piping	¼ - 12	Schedule Tables	ASTM B241	ASTM B241	6063-T6	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12
404	0.00	Thickness	10	10	10	10	10	10	10	10	40	40	40	40	40

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
404	0.00	Thickness	40	40	40	40	40	40	80	40	40	40

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Socket Weld Fittings	¼ - 2	3000#	ASTM B361	ASTM B361	WP6061	Ref. ASME B16.11 for dimensions
Buttweld Fittings	½ - 12	Schedule Tables	ASTM B361	ASTM B361	WP6061	Ref. ASME B16.9 for dimensions
Buttweld Fittings	½ - 12	Schedule Tables	ASTM B361	ASTM B361	WP6061	Ref. ASME B16.28 for dimensions

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 1⅝	Class 150	B31.3 App. L	ASTM B247	6061-T6	ASME B16.5 for dimensions
Threaded Flanges	½ - 1⅝	Class 150	B31.3 App. L	ASTM B247	6061-T6	ASME B16.5 for dimensions

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅞	N/A	ASME B18.2.1	ASTM A193	B8 Cl. 1- HH	Min temperature - 325°F, See note 10
Fasteners	½ - ⅞	N/A	ASME B18.2.1	ASTM B211	6061 - T6 - HH	See note 10
Nuts	½ - ⅞	N/A	ASME B18.2.2	ASTM A194	8F- HH	Use with B8 Cl. 1
Nuts	½ - ⅞	N/A	ASME B18.2.2	ASTM B211	6061 - T6 - HH	Use with 6061 - T6 Fastener

Piping Specification 405	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-405			
Design Pressure (psig)	275	270	265	260
Design Temperature (°F)	100	150	200	250
Minimum Temperature (°F)	-452	-452	-452	-452
Minimum Test Pressure (psig)	415	405	400	390
Maximum Test Pressure (psig)	455			

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Aluminum (6061/6063)
Pressure Rating:	275 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1-9, 28.

Allowable Tube Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tubing	⅛ - 2	Schedule Tables	ASTM B241	ASTM B241	6061-T6	Seamless
Tubing	⅛ - 2	Schedule Tables	ASTM B241	ASTM B241	6063-T6	Seamless

Required Schedules for Tube

P-Spec	Corrosion Allowance	Pipe Size	⅛	3/16	¼	5/16	⅜	½	⅝	¾	⅞	1	1¼	1½	2
405	0.00	Thickness	0.035	0.035	0.035	0.035	0.035	0.035	0.049	0.049	0.049	0.065	0.065	0.083	0.095
Bend Radius			1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D	1.5D

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Tube	⅛ - 2	Manufacturer's	Manufacturer's	ASTM B211	6061 - T6	
Buttweld Fittings	¼ - 1	Manufacturer's	Manufacturer's	ASTM B211	2014T	

Piping Specification 500	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-500
Design Pressure (psig)	150
Design Temperature (°F)	100
Minimum Temperature (°F)	0
Minimum Test Pressure (psig)	225
Maximum Test Pressure (psig)	590

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	PVC
Pressure Rating:	150 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1-3, 5-7, 9, 10, 13, 28 -30.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 8	Schedule Tables	ASTM D1784	ASTM D1784	12454-B	Note 30
Piping	¼ - 8	Schedule Tables	ASTM D1784	ASTM D1784	12454-C	Note 30

Required Schedules for Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8
500	0.00	Schedule	40	40	40	40	40	40	40	40	40	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	40	ASTM D2466	ASTM D1784	12454-B, 12454-C	
Threaded Fittings	½ - 4	80	ASTM D2464	ASTM D1784	12454-B, 12454-C	
Solvent Welded Fittings	½ - 8	80	ASTM D2467	ASTM D1784	12454-B, 12454-C	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	¼ - 8	Class 150	ASME B16.5	ASTM A105	N/A	
Threaded Flange	½ - 8	Class 150	ASME B16.5	ASTM A182	304L/316L	
Solvent Welded Flange	½ - 8	Sch. 80	Manufacturer's	ASTM D1784	12454-B, 12454-C	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A307	Grade A	See Note 10.
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A563	Grade B	

Piping Specification 501	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-501	
Design Pressure (psig)	150	40
Design Temperature (°F)	100	180
Minimum Temperature (°F)	0	0
Minimum Test Pressure (psig)	280	240
Maximum Test Pressure (psig)	310	

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	CPVC
Pressure Rating:	150 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1-3, 5-7, 9, 10, 13, 29 - 31.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 8	Schedule Tables	ASTM F441	ASTM D1784	23447-B (CPVC 4120)	Note 30
Piping	¼ - 8	Schedule Tables	ASTM F442	ASTM D1784	23447-B (CPVC 4120)	Note 30, 31.

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8
501	0.00	Schedule	40	40	40	40	40	40	40	40	40	80	80

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4
501	0.00	Schedule	80	80	80	80	80	-	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	80	ASTM F437	ASTM D1784	23447-B (CPVC 4120)	
Solvent Welded Fittings	¼ - 4	40	ASTM F438	ASTM D1784	23447-B (CPVC 4120)	
Solvent Welded Fittings	¼ - 8	80	ASTM F439	ASTM D1784	23447-B (CPVC 4120)	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 8	Class 150	ASME B16.5	ASTM A105	N/A	
Threaded Flange	½ - 8	Class 150	ASME B16.5	ASTM A182	304L/316L	
Solvent Welded Flange	½ - 8	Sch. 80	Manufacturer's	ASTM D1784	23447-B (CPVC 4120)	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ¾	N/A	ASME B18.2.1	ASTM A307	Grade A	See Note 10
Nuts	½ - ¾	N/A	ASME B18.2.2	ASTM A563	Grade B	

Piping Specification 502 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-502 (A, B, C, D, E, F, G)						
Design Pressure (psig)	200	193	160	128	110	100	80
Design Temperature (°F)	73	73	73	73	73	73	73
Minimum Temperature (°F)	0	0	0	0	0	0	0
Minimum Test Pressure (psig)	300	290	240	190	165	150	120
Maximum Test Pressure (psig)	330						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	B31.3, 2002
Fluid Service:	Normal
Material:	Polyethylene (PE)
Pressure Rating:	200 psi

General Notes

Refer to General Notes 1-3, 5, 7, 9-11, 13, 29, 30, 32, 33.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	½ - 12	Design Parameters	ASTM D3035	ASTM D3035	PE3408	Note 30
Piping	½ - 12	Design Parameters	ASTM D2513	ASTM D3035	PE3408	Note 30
Tubing	¼ - 1 ¾	Design Parameters	ASTM D2513	ASTM D3035	PE3408	Note 30
Tubing	½ - 2	Design Parameters	ASTM D2737	ASTM D3035	PE3408	Note 30

Required DR Schedules for Pipe

P-Spec	Corrosion Allowance	Design Pressure at 73°	Pipe Size	½	¾	1	1 ¼	1½	2	3	4	6	8	10	12	14
A	0.00	200	DR	9	9	9	9	9	9	9	9	9	9	9	9	9
B	0.00	193	DR	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
C	0.00	160	DR	11	11	11	11	11	11	11	11	11	11	11	11	11
D	0.00	128	DR	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
E	0.00	110	DR	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
F	0.00	100	DR	17	17	17	17	17	17	17	17	17	17	17	17	17
G	0.00	80	DR	21	21	21	21	21	21	21	21	21	21	21	21	21

Required DR Schedules for Tube

P-Spec	Corrosion Allowance	Design Pressure at 73°	Pipe Size	¼	⅜	½	⅝	¾	1	1 ¼	1 ½	1 ¾	2
A	0.00	200	DR	9	9	9	9	9	9	9	9	9	9
B	0.00	193	DR	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
C	0.00	160	DR	11	11	11	11	11	11	11	11	11	11
D	0.00	128	DR	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
E	0.00	110	DR	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
F	0.00	100	DR	17	17	17	17	17	17	17	17	17	17
G	0.00	80	DR	21	21	21	21	21	21	21	21	21	21

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Butt Fusion Fittings	¼ - 12	Note	ASTM D3261	ASTM D1248	P34 (PE3408)	
Solvent Welded Fittings (Pipe)	¼ - 4	Note	ASTM D2683	ASTM D1248	P34 (PE3408)	Type III, Class B or C
Solvent Welded Fittings (Pipe)	¼ - 1¼	Note	ASTM D2683	ASTM D1248	P34 (PE3408)	Type III, Class B or C

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Backup Flange Flange	½ - 12	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅞	N/A	ASME B18.2.1	ASTM A307	Grade A	See Note 10.
Nuts	½ - ⅞	N/A	ASME B18.2.2	ASTM A563	Grade B	

Piping Specification 900	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-900(A, B, C, D)						
Design Pressure (psig)	285	230	170	140	110	95	80
Design Temperature (°F)	100	300	500	600	700	750	800
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	430	345	270	245	200	220	220
Maximum Test Pressure (psig)	820						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.1, 2001
Fluid Service:	Non-BEP
Material:	Carbon Steel
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 3, 4, 6, 8-12, 34-39.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	See General Note 38.
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
B	0.03	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
C	0.05	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
D	0.07	Schedule	80	80	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.030	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
C	0.060	Schedule	80	80	80	80	80	80	STD	STD	STD	STD
D	0.070	Schedule	-	160	160	80	80	80	80	80	80	STD

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#	ASME B16.11	ASTM A105	WP	Only where threaded pipe is ≤ sch. 80
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WP	
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	Limited to 600°F, See Note 10.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 901 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-901(A, B, C, D)						
Design Pressure (psig)	740	655	600	550	535	535	505
Design Temperature (°F)	100	300	500	600	650	700	750
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	1110	985	950	955	945	975	1165
Maximum Test Pressure (psig)	1325						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.1, 2001
Fluid Service:	Non-BEP
Material:	Carbon Steel
Pressure Rating:	Class 300
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 3, 4, 6, 8-12, 34-39.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	See General Note 38.
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	40	XS	40	40
B	0.03	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	40	40	XS	40	40
C	0.05	Schedule	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	40	40	40	40	40
D	0.07	Schedule	80	80	80	80	80	80	STD	STD	80	80	STD	STD	XS	XS	40	40	40	40

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.030	Schedule	80	80	80	80	80	80	80	80	80	80
C	0.060	Schedule	-	80	80	80	80	80	80	80	80	80
D	0.070	Schedule	-	160	160	160	160	160	80	80	80	80

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#/3000#	ASME B16.11	ASTM A105	WPB	2000# only where threaded pipe is ≤ sch. 80
Socket-Weld Fittings	¼ - 2	3000#	ASME B16.11	ASTM A105	WPB	
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1½	ASME B18.2.1	ASTM A193	B7-HH	Limited to 600°F, See Note 10.
Nuts	½ - 1½	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 902	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-902(A, B, C, D)						
Design Pressure (psig)	1480	1315	1200	1095	1075	1065	1010
Design Temperature (°F)	100	300	500	600	650	700	750
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	2220	1975	1905	1900	1900	1935	2330
Maximum Test Pressure (psig)	2740						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.1, 2001
Fluid Service:	Non-BEP
Material:	Carbon Steel
Pressure Rating:	Class 600
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 3, 4, 6, 8-12, 34-39.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A53	B	See General Note 38
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	STD	STD	STD	STD	STD	STD	STD	80	80	80	80	80	80	80	80	80	80	80
B	0.03	Schedule	STD	STD	STD	STD	80	80	80	80	80	120	80	80	80	80	80	100	100	100
C	0.05	Schedule	80	80	160	80	80	160	80	80	120	120	80	100	100	100	100	100	100	100
D	0.07	Schedule	-	160	160	160	160	160	160	160	120	120	100	100	100	100	100	100	100	100

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	80	80	80	120	120
B	0.030	Schedule	80	80	80	160	160	160	160	160	120	120
C	0.060	Schedule	-	160	160	160	160	160	160	160	120	120
D	0.070	Schedule	-	XXS	160	160	160	160	160	160	120	120

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	3000#	ASME B16.11	ASTM A105	WPB	Only where threaded pipe is ≤ sch. 160
Socket-Weld Fittings	¼ - 2	3000#/6000#	ASME B16.11	ASTM A105	WPB	3000# only where pipe is ≤ sch. 80
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	¼ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded FLange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1½	ASME B18.2.1	ASTM A193	B7-HH	Limited to 600°F, See Note 10.
Nuts	½ - 1½	ASME B18.2.2	ASTM A194	2H-HH	

Piping Specification 903	Date: September 17, 2014	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-903(A, B, C, D)						
Design Pressure (psig)	150	132	112	93	75	60	45
Design Temperature (°F)	73	90	100	110	120	130	140
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	225	225	225	225	225	225	225
Maximum Test Pressure (psig)	250						

Calculation Reference:	**00-00-CALC-M-0004-R0**
Code of Reference:	AWWA
Fluid Service:	Water
Material:	PVC
Pressure Rating:	150 psi

General Notes

Refer to General Notes 3, 9, 10, 13, 40-45.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	4 - 12	Schedule Tables	AWWA C900	ASTM D1784	12454-A or B	
Piping	14 - 36	Schedule Tables	AWWA C905	ASTM D1784	12454-A or B	

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	4	6	8	10	12	14	16	18	20	24	30	36
A	0.00	Schedule	18	18	18	18	18	26	26	26	26	26	26	26

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
PVC Fittings	4 – 8	Cl. 150 (DR 18)	AWWA C907	ASTM D1784	12454-A or 12454-B	Push-on
Ductile Iron Fittings	4 – 16	350	AWWA C153/A21.53	ASTM A536	DI	Push-on or Mechanical
Ductile Iron Fittings	4 – 36	350	AWWA C110/A21.10	ASTM A536	DI	Push-on or Mechanical
Grey Iron Fittings	4 - 36	150 or 250	AWWA C110/A21.10	A48	25 or 30	Push-on or Mechanical

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Ductile Iron Fittings	4 – 36	350	AWWA C110/A21.10	ASTM A536	DI	
Grey Iron Fittings	4 - 36	150 or 250	AWWA C110/A21.10	A48	25 or 30	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	⅝ - 1½	ASME B18.2.1	ASTM A307	Grade A	See note 10.
Nuts	⅝ - 1½	ASME B18.2.2	ASTM A563	Grade B	

Piping Specification 904 Date: September 17, 2014 Revision: 0 Page 1 of 1

Design Parameters

P-Spec	PS-904
Design Pressure (psig)	250
Design Temperature (°F)	150
Minimum Temperature (°F)	0
Minimum Test Pressure (psig)	375
Maximum Test Pressure (psig)	400

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	AWWA
Fluid Service:	Water
Material:	Ductile Iron
Pressure Rating:	250 psi

General Notes

Refer to General Notes 3, 9, 10, 13, 41, 44, 46-50.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	3 - 64	Schedule Tables	AWWA C151	ASTM A48	DI	
Piping	3 - 64	Schedule Tables	AWWA C115	ASTM A48/A536	DI	Threaded Ends

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	3	4	6	88	10	12	14	16	18	20	24	30	36	42	48	54	60	64
A	0.00	Schedule	350	350	350	350	350	350	250	250	250	250	250	250	250	250	250	250	250	250

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	3	4	6	88	10	12	14	16	18	20	24	30	36	42	48	54	60	64
A	0.00	Schedule	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Ductile Iron Push-on	3 - 48	250	AWWA C111/A21.11	ASTM A536	DI	
Ductile Iron Fittings	3 - 16	350	AWWA C153/A21.53	ASTM A536	DI	
Ductile Iron Fittings	3 - 48	350	AWWA C110/A21.10	ASTM A536	DI	
Grey Iron Fittings	3 - 48	250	AWWA C110/A21.10	A48	30	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Ductile Iron Fittings	3 - 48	350	AWWA C110/A21.10	ASTM A536	DI	
Grey Iron Fittings	3 - 48	250	AWWA C110/A21.10	A48	30	
Ductile Iron Flanges	3 – 24	250	AWWA C115/A21.15	ASTM A536	DI	Threaded Flanges
Grey Iron Flanges	3 – 24	250	AWWA C115/A21.15	A48	30	Threaded Flanges

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	⅝ - 1½	ASME B18.2.1	ASTM A307	Grade A	See note 10.
Nuts	⅝ - 1½	ASME B18.2.2	ASTM A563	Grade B	

APPENDIX B – FLUID SERVICE SHEETS

This appendix contains data on selecting the appropriate materials to be used in a specific fluid service. This data should be used with caution because it represents cases where the chemistry of the specified fluid is well understood. The recommendations made in the Fluid Service Sheets are one option based on economic and technical considerations. Other options may be technically acceptable. Questions about corrosion allowance values for a specific fluid service should be directed to ESM Pressure Safety Point-of-Contact. An index to the Fluid Service Sheets is provided below.

FLUID SERVICE SHEET REVISION CONTROL PAGE			
SERVICE	**REVISION**	**PAGES**	**DESCRIPTION OF REVISION**
Air (Breathing)	0	1	Original Issue
Air (Compressed/Plant)	0	1	Original Issue
Caustic	0	1	Original Issue
Diesel Fuel	0	1	Original Issue
Nitric Acid (0-65%)	0	1	Original Issue
Nitric Acid (0-95%)	0	1	Original Issue
Nitrogen (Cryogenic)	0	1	Original Issue
Oxalic Acid	0	1	Original Issue
Oxygen (Liquid or Gas)	0	1	Original Issue
Refrigerants	0	1	Original Issue
Steam (Low Pressure)	0	1	Original Issue
Steam (Medium Pressure)	0	1	Original Issue
Sulfuric Acid (0-100%)	0	1	Original Issue
Sulfuric Acid (70-100%)	0	1	Original Issue
Water (DI)	0	1	Original Issue
Water (Domestic)	0	1	Original Issue
Water (Heavy/Contaminated)	0	1	Original Issue
Water (Raw/Untreated)	0	1	Original Issue
Water (Service)	0	1	Original Issue

Fluid Service: Air (Breathing)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101B	0.031	200	200	
Stainless Steel Pipe	PS-200A	0	195	200	

Gaskets

Material	Flange Face Finish	Additional Requirements
Reinforced Teflon	125-250	

Notes

1) See Appendix C for Pressure-Temperature Rating of Gaskets
2) Stainless steel is required downstream of the filter.
3) Piping runs can utilize butt welded, socket welded, or threaded connections.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	2-Bronze, 4-Carbon Steel (1), 5-Stainless Steel 304(L) (2), 6-Stainless Steel 316(L) (3)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection (4)	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CB-Ball Check, GW-Solid Wedge Gate, TN-Needle Globe, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%), C-Bronze, D-Stainless Steel
	8) Seat Material	A-Chromium (11-13%), D-Stainless Steel, O-Viton, P-EPDM
	9) Stem Material	A-Chromium (11-13%), B-Carbon Steel, C-Bronze, D-Stainless Steel
	10) Packing Material	A-Graphite, B-Teflon, D-Nylon, G-Viton, H-EPDM
	11) Body Gasket	B-Teflon, D-Nylon, G-Viton, H-EPDM

Notes

1) ASTM A216WCB or A105
2) CF3, CF8, F304, or F304L
3) CF3M, CF8M, F316, F316L
4) Non welded end stainless steel valves pressure rating is based on the high carbon (non L) grade.

Fluid Service: Air (Compressed/Plant)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101B	0.031	200	200	

Gaskets

Material	Flange Face Finish	Additional Requirements
NBR Bonded Aramid Fiber	125-250	

Notes

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Piping runs can utilize butt welded, socket welded, or threaded connections.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	2-Bronze, 4-Carbon Steel (1)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CB-Ball Check, GW-Solid Wedge Gate, TN-Needle Globe, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%), C-Bronze
	8) Seat Material	A-Chromium (11-13%), O-Viton, P-EPDM
	9) Stem Material	A-Chromium (11-13%), B-Carbon Steel, C-Bronze
	10) Packing Material	A-Graphite, B-Teflon, D-Nylon, G-Viton, H-EPDM
	11) Body Gasket	B-Teflon, D-Nylon, G-Viton, H-EPDM

Notes

1) ASTM A216WCB or A105

Fluid Service: Caustic Soda (0 – 50% NaOH)	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101B	0.031	200	200	

GASKETS

Material	Flange Face Finish	Additional Requirements
NBR Bonded	125-250	May be used with Flat Face Flanges

NOTES

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Material selection in this fluid service is critical and changes should be made with caution.
3) Flanged connections should be minimized and only used when required for component and equipment connections.
4) Threaded connections should only be allowed for instrument connections.
5) Socket welded connections are not permitted for this fluid service.
6) Welds and cold bends are required to be stress relieved under the conditions in the following table.

Concentration NaOH vs. Temperature Requiring Stress Relief

Concentration (% NaOH)	Temperature (°F)
0	180
20	160
30	140
50	115

VALVES

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	4-Carbon Steel (1), 5-Stainless Steel 304(L) (2), 6-Stainless Steel 316(L) (3), 7-Monel
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged, 3-Butt Weld
	5) Type of Valve	BL-Ball, CL-Lift Check, CT-Tilting Disk Check, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%) (5), D-Stainless Steel, E-Monel
	8) Seat Material	A-Chromium (11-13%) (5), D-Stainless Steel, E-Monel, J-Teflon, P-EPDM
	9) Stem Material	A-Chromium (11-13%) (5), D-Stainless Steel, E-Monel
	10) Packing Material	A-Graphite, B-Teflon, H-EPDM
	11) Body Gasket	A-Graphite, B-Teflon, H-EPDM

NOTES

1) ASTM A216WCB or A105
2) CF3, CF8, F304, or F304L
3) CF3M, CF8M, F316, F316L

4) Non-welded-end stainless steel valves pressure rating is based on the high carbon (non L) grade.
5) Limit Chromium (11 – 13%) to 100° F.

Fluid Service: Diesel Fuel	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101B	0.031	50	120	Socket or Buttweld Runs

GASKETS

Material	Flange Face Finish	Additional Requirements
Spiral Wound Teflon Fill	125-250	Low Stress Style

NOTES

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Material selection in this fluid service is critical and changes should be made with caution.
3) Flanged connections should be minimized and only used when required for component and equipment connections.
4) Piping runs can utilize butt welded, socket welded, or threaded connections.

VALVES

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	4-Carbon Steel (1), 5-Stainless Steel 304(L) (2), 6-Stainless Steel 316(L) (3), 7-Monel
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged , 3-Butt Weld
	5) Type of Valve	BL-Ball, CL-Lift Check, CT-Tilting Disk Check, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%), D-Stainless Steel
	8) Seat Material	A-Chromium (11-13%), D-Stainless Steel, J-Teflon
	9) Stem Material	A-Chromium (11-13%), D-Stainless Steel
	10) Packing Material	A-Graphite, B-Teflon
	11) Body Gasket	A-Graphite, B-Teflon

NOTES

1) ASTM A216WCB or A105
2) CF3, CF8, F304, or F304L
3) CF3M, CF8M, F316, F316L
4) Non welded end stainless steel valves pressure rating is based on the high carbon (non L) grade.

Fluid Service: Nitric Acid (0 – 65%)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel	PS-200D	0.08	195	200 (1)	Use only low carbon (L grade) material

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound Teflon Fill	125-250	Low Stress Style

Notes

1) Temperature limits are set to control corrosion.
2) Piping wall thickness should be examined on a periodic basis.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) Material selection in this fluid service is critical and changes should be made with caution.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.
7) Socket welded connections are not permitted for this fluid service.
8) Corrosion evaluated materials are recommended for this fluid service.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	5-Stainless Steel 304(L) (1), 6-Stainless Steel 316(L) (2)
	3) Pressure Class	1-150
	4) End Connection	1-Flanged , 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel,
	8) Seat Material	D-Stainless Steel, J-Teflon, O-Viton
	9) Stem Material	D-Stainless Steel
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

1) CF3, CF8, F304, or F304L
2) CF3M, CF8M, F316, F316L

Fluid Service: Nitric Acid (0-95%)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel	PS-200D	0.08	230	100 (1)	Use only low carbon (L grade) material

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound Teflon Fill	125-250	Low Stress Style

Notes

1) Temperature limits are set to control corrosion.
2) Piping wall thickness should be examined on a periodic basis.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) Material selection in this fluid service is critical and changes should be made with caution.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.
7) Socket welded connections are not permitted for this fluid service.
8) Corrosion evaluated materials are recommended for this fluid service

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	5-Stainless Steel 304(L) (1), 6-Stainless Steel 316(L) (2)
	3) Pressure Class	1-150
	4) End Connection	1-Flanged (8), 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel,
	8) Seat Material	D-Stainless Steel, J-Teflon, O-Viton
	9) Stem Material	D-Stainless Steel
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

1) F304L
2) F316L

Fluid Service: Nitrogen (cryogenic)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel	PS-200	0.00	100	See P-spec	

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Teflon Fill	125-250	Style Low Stress (LS)

Notes

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Material selection in this fluid service is critical and changes should be made with caution.
3) Flanged connections should be minimized and only used when required for component and equipment connections.
4) Threaded connections should only be allowed for instrument connections.
5) The minimum temperature may govern the design of this piping system and require impact testing for certain material and welding procedures.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	5-Stainless Steel 304(L) (1)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged , 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, DV-Diaphragm, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel,
	8) Seat Material	D-Stainless Steel, J-Teflon, O-Viton
	9) Stem Material	D-Stainless Steel
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

1) CF3, CF8, F304, or F304L

Fluid Service: Oxalic Acid (0-100%)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel	PS-201B	0.03	100	125 (1)	

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Teflon Fill	125-250	Style Low Stress (LS)

Notes

1) Temperature limits are set to control corrosion.
2) Piping wall thickness should be examined on a periodic basis.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) Material selection in this fluid service is critical and changes should be made with caution.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.
7) Socket welded connections are not permitted for this fluid service.
8) Corrosion evaluation of the materials is recommended of this fluid service.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	6-Stainless Steel 316(L) (1), 8-Alloy 20
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged , 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, DV-Diaphragm, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel, F-Alloy 20
	8) Seat Material	D-Stainless Steel, F-Alloy 20, J-Teflon, O-Viton
	9) Stem Material	D-Stainless Steel, F-Alloy 20
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

1) CF8, CF8M, F316, F316L

Fluid Service: Oxygen (gas or liquid)	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel	PS-201B	0.03	100	See P-spec	

GASKETS

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Teflon Fill	125-250	Style Low Stress (LS)

NOTES

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Material selection in this fluid service is critical and changes should be made with caution.
3) Components with ferrous materials shall not be used in this fluid service.
4) Components and piping in this system shall be cleaned prior to start up. See Appendix K for cleaning guidance.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.

VALVES

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	6-Stainless Steel 316(L) (1)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged, 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, DV-Diaphragm, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel,
	8) Seat Material	D-Stainless Steel, J-Teflon, O-Viton
	9) Stem Material	D-Stainless Steel
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

NOTES

1) CF8, CF8M, F316, F316L

Fluid Service: Refrigerant	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Copper Tube	PS-403	0	400	See P-Spec	Braze all connections

Gaskets

Material	Flange Face Finish	Additional Requirements
EPDM	250-500	For Full Face Applications ≤ 100 psi, -20° F minimum temp.

Notes

1) Full face gaskets are required for flat face flanges.
2) Flanges should only be used for fit-up flanged components in copper piping systems
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) There are many suitable materials for this fluid service. The selections below are strictly for guidance.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	1-Brass
	3) Pressure Class	2-300
	4) End Connection	6-Solder (Brazed), 9-Compression
	5) Type of Valve	BL-Ball, CB-Ball Check, CP-Poppet Check, TN-Needle Globe, TS-Standard Globe, V3-Three Way Valve (1)
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	H-Brass,
	8) Seat Material	D-Stainless Steel, H-Brass, J-Teflon
	9) Stem Material	D-Stainless Steel, H-Brass
	10) Packing Material	A-Graphite, B-Teflon
	11) Body Gasket	A-Graphite, B-Teflon

Notes

1) Specify port requirement

Fluid Service: Steam (Low Pressure)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel	PS-102C	0.0625	285	See P-spec	

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Graphite Fill	125-250	Style Low Stress (LS)

Notes

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Piping runs can utilize butt welded, socket welded, or threaded connections.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	4-Carbon Steel (1)
	3) Pressure Class	1-150
	4) End Connection	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CL-Lit Check, CS-Swing Check, GF-Flex/Split Wedge Gate, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%)
	8) Seat Material	A-Chromium (11-13%), B-Stellite (Hard Face)
	9) Stem Material	A-Chromium (11-13%)
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite

Notes

1) ASTM A216WCB or A105

Fluid Service: Steam (Medium Pressure)	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel	PS-103C	0.0625	600	See P-spec	

GASKETS

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Graphite Fill	125-250	Style Low Stress (LS)

NOTES

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Piping runs can utilize butt welded, socket welded, or threaded connections.

VALVES

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	4-Carbon Steel (1)
	3) Pressure Class	1-150
	4) End Connection	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CL-Lift Check, CS-Swing Check, GF-Flex/Split Wedge Gate, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%)
	8) Seat Material	A-Chromium (11-13%), B-Stellite (Hard Face)
	9) Stem Material	A-Chromium (11-13%)
	10) Packing Material	A-Graphite
	11) Body Gasket	A-Graphite

NOTES

1) ASTM A216WCB or A105

Fluid Service: Sulfuric Acid (0-100%)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Hastelloy C-276	PS-300D	0.095	100	150 (1)	
Alloy 20	PS-302D	0.07	100	150 (1)	

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Teflon Fill	125-250	Style Low Stress (LS)

Notes

1) Temperature limits are set to control corrosion.
2) Piping wall thickness should be examined on a periodic basis.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) Material selection in this fluid service is critical and changes should be made with caution.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.
7) Socket welded connections are not permitted for this fluid service.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	8-Alloy 20, 9-Hastelloy
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged , 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, DV-Diaphragm, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	F-Alloy 20, G-Hastelloy
	8) Seat Material	F-Alloy 20, G-Hastelloy, O-Viton
	9) Stem Material	F-Alloy 20, G-Hastelloy
	10) Packing Material	A-Graphite, B-Teflon, G-Viton
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

Fluid Service: Sulfuric Acid (70-100%)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel	PS-101D	0.125	100	100 (1)	3 FPS>Fluid Velocity>1 FPS

Gaskets

Material	Flange Face Finish	Additional Requirements
Spiral Wound/Teflon Fill	125-250	Style Low Stress (LS)

Notes

1) Temperature limits are set to control corrosion.
2) Piping wall thickness should be examined on a periodic basis.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.
4) Material selection in this fluid service is critical and changes should be made with caution.
5) Flanged connections should be minimized and only used when required for component and equipment connections.
6) Threaded connections should only be allowed for instrument connections.
7) Socket welded connections are not permitted for this fluid service.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	4, Carbon Steel (1), 8-Alloy 20, 9-Hastelloy
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged, 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, DV-Diaphragm, GW-Solid Wedge Gate
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	F-Alloy 20, G-Hastelloy
	8) Seat Material	F-Alloy 20, G-Hastelloy, O-Viton
	9) Stem Material	F-Alloy 20, G-Hastelloy
	10) Packing Material	A-Graphite, B-Teflon, G-Viton
	11) Body Gasket	A-Graphite, B-Teflon, G-Viton

Notes

1) ASTM A216WCB or A105

Fluid Service: Water (DI)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Stainless Steel Pipe	PS-200B	0.03	230	See P-Spec	
PVC	PS-500	0	150	See P-Spec	For Laboratory Applications (3)

Gaskets

Material	Flange Face Finish	Additional Requirements
Reinforced Teflon	125-250	
EPDM	250-500	For Full Face Applications ≤ 100 psi

Notes

1) Use only full face gaskets with flat face flanges.
2) See Appendix C for Pressure-Temperature Rating of Gaskets.
3) To ensure purity of DI water for chemical metallurgical research, all wetted parts of the piping system, including components, must be non-metallic. The use of non-metallic valves would require the qualification of unlisted components.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	5-Stainless Steel (1), 6-Stainless Steel (2)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CB-Ball Check, GW-Solid Wedge Gate, TN-Needle Globe, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%), C-Bronze, D-Stainless Steel, O-Viton, P-EPDM
	8) Seat Material	A-Chromium (11-13%), D-Stainless Steel, O-Viton, P-EPDM
	9) Stem Material	A-Chromium (11-13%), B-Carbon Steel, C-Bronze, D-Stainless Steel
	10) Packing Material	A-Graphite, B-Teflon, D-Nylon, G-Viton, H-EPDM
	11) Body Gasket	B-Teflon, D-Nylon, G-Viton, H-EPDM

Notes

1) CF3, CF8, F304, or F304L
2) CF8, CF8M, F316, F316L

Fluid Service: Water (Domestic)	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel	PS-101B	0.031	200	See P-Spec	
PVC	PS-903	0	150	See P-Spec	For Buried Applications
PVC	PS-500	0	200	See P-Spec	

GASKETS

Material	Flange Face Finish	Additional Requirements
Reinforced Teflon	125-250	
EPDM	250-500	For Full Face Applications ≤ 100 psi.

NOTES

1) Use only Full Face gaskets with Flat Face Flanges.
2) Gaskets in push-on joints should be per the piping manufacturer's standard.
3) See Appendix C for Pressure-Temperature Rating of Gaskets.

VALVES

The valve ID numbering system is defined in Appendix D.

There are many suitable materials for this fluid service. Selections may be based on owner preference

Fluid Service: Water (Heavy/Contaminated)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	**P-Spec**	**Corrosion Allowance (in)**	**Max Pressure (psi)**	**Max Temperature (°F)**	**Additional Requirements**
Stainless Steel Pipe	PS-200A	0.0	200	See P-Spec	

Gaskets

Material	**Flange Face Finish**	**Additional Requirements**
Spiral Wound/Graphite Fill	125-250	

Notes

1) See Appendix C for Pressure-Temperature Rating of Gaskets.
2) Material selection in this fluid service is critical and changes should be made with caution.
3) Flanged connections should be minimized and only used when required for component and equipment connections.
4) Threaded connections should only be allowed for instrument connections.
5) Socket welded connections are not permitted for this fluid service.

Valves

The valve ID numbering system is defined in Appendix D.

	Feature	**Feature Specifications**
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	5-Stainless Steel 304/304L (1), 6-Stainless Steel 316/316L (2)
	3) Pressure Class	0-125, 1-150, P-Pressure Rated
	4) End Connection	1-Flanged (4), 3-Butt Weld
	5) Type of Valve	BL-Ball, CB-Ball Check, CL-Lift Check, CS-Swing Check, GW-Solid Wedge Gate, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	D-Stainless Steel
	8) Seat Material	D-Stainless Steel, R-UHMWPE
	9) Stem Material	D-Stainless
	10) Packing Material	A-Graphite, R -UHMWPE
	11) Body Gasket	A-Graphite, R-UHMWPE

Notes

1) CF3, CF8, F304, or F304L
2) CF8, CF8M, F316, F316L

Fluid Service: Water (Raw/Untreated)	Page 1 of 1	Revision: 0	Date: 9/17/14

GENERAL INFORMATION

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101B	0.031	285	See P-Spec	Cement Lined (1)
PVC	PS-903	0	150	See P-Spec	For buried applications
PVC	PS-500	0	150	100	
CPVC	PS-501	0	150	See P-Spec	

GASKET

Material	Flange Face Finish	Additional Requirements
Reinforced Teflon	125-250	Carbon steel piping systems
EPDM	250-500	For Full Face Applications ≤ 100 psi.

NOTES

1) Cement Lining should be per AWWA C205
2) See Appendix C for Pressure-Temperature Rating of Gaskets.
3) Gaskets in push-on joins should be per the piping manufacturer's standard.
5) No wetted parts should be composed of copper or alloys that are high in copper content.

VALVES

The valve ID numbering system is defined in Appendix D.

There are many suitable materials for this fluid service. Selections may be based on owner preference

Fluid Service: Water (Service)	Page 1 of 1	Revision: 0	Date: 9/17/14

General Information

Material	P-Spec	Corrosion Allowance (in)	Max Pressure (psi)	Max Temperature (°F)	Additional Requirements
Carbon Steel Pipe	PS-101C	0.063	285	See P-Spec	
PVC	PS-903	0	150	See P-Spec	For buried applications
PVC	PS-500	0	150	100	
CPVC	PS-501	0	150	See P-Spec	

Gaskets

Material	Flange Face Finish	Additional Requirements
Reinforced Teflon	125-250	Carbon steel piping systems
EPDM	250-500	For Full Face Applications ≤ 100 psi.

Notes

1) Use only full face gaskets with flat face flanges.
2) See Appendix C for Pressure-Temperature Rating of Gaskets.
3) Gaskets in push-on joins should be per the piping manufacturer's standard.

Valves

The valve ID numbering system is defined in Appendix D.

There are many suitable materials for this fluid service. Selections may be based on owner preference

APPENDIX C – MATERIALS SELECTION

This appendix contains information on selecting gaskets and materials for pipe, fittings, valve bodies, and packing. There are many factors that influence the proper selection of a material. These factors include the pressure/temperature rating of the piping system and gasket material compatibility with the fluid service. The following general guidance is provided for material selection.

The following information provides a general description of some common materials and the service where they might be used. This information is not definitive or all-inclusive. For severe fluid services, additional research on material acceptability is required, and in all cases the final responsibility of material selection resides with the cognizant engineering organization.

Gaskets

The gaskets listed in Table 1 are the most commonly used gasket materials at the LANL. Other gasket materials are used in special applications. The use of these other gasket materials is acceptable when properly rated for pressure, temperature and compatibility with the fluid service.

Gaskets must be able to:

a) Maintain integrity during handling and installation.
b) Be sufficiently deformable to flow into imperfections on the seating surfaces to create an initial seal.
c) Have sufficient strength to resist crushing under the applied load and defy rupture under pressure.
d) Chemically resist fluid under all temperatures and pressures.
e) Be strong enough to maintain the seal, tough enough to withstand creep relaxation, and resilient enough to provide recovery during normal operation including thermal cycling and vibration.
f) Never promote corrosion of the seating surface.
g) Be impermeable to the fluid being handled.
h) Be sufficiently resistant to radiation, if present, to perform its function.

Guidance for selection of gaskets in specific fluid services is provided in Appendix B “Fluid Service Sheets.”

Refer to Table 1 for the pressure/temperature rating of some commonly used gasket materials. Refer to Appendix E for torquing requirements.

Table 1 - Gasket Material Pressure/Temperature Ratings

Gasket Material	Maximum Pressure	Minimum Temperature	Maximum Temperature	Comments
Nitrile (NBR, Buna-N)	150 psi	-20°F	250°F	
Neoprene (35 IRHD, 60 IRHD, 75 IRHD)	150 psi	-20°F	212°F	
EPDM (70 IRHD)	150 psi	-20°F	350°F	
Graphite	2000 psi	-300°F	850°F	Note 1
Viton (60 IRHD, 80 IRHD)	150 psi	-20°F	392°F	
Reinforced Teflon	800 psi	-350°F	550°F	Note 2
NBR/Synthetic Fiber (Inorganic Fiber)	1200 psi	-40°F	550°F	
EPDM/Aramid Fiber	1200 psi	-40°F	550°F	Note 3
NBR/Aramid Fiber	1000 psi	-40°F	550°F	Note 3
SBR/Aramid Fiber	1200 psi	-40°F	550°F	Note 3
Spiral Wound - Teflon	Class 2500	-350°F	500°F	
Spiral Wound - Graphite	Class 2500	-300°F	850°F	

General Notes:

A. Non-Spiral Wound Gaskets should be specified in thicknesses of either 1/16" or 1/8". The thinner (1/16") is preferred.

B. Pressure and temperature ratings are generic based on available manufacturer's data. Refer to the Garlock catalog, the Lamons catalog, and the Flexitallic catalog. Specific ratings for these and other company products may vary, and cautions should be exercised when specifying gaskets close to the limiting conditions. Gaskets with pressure and temperature ratings higher than those identified above are available, and should be specified on a case-by-case basis. Other gasket materials may be available and more suitable for some services. The ESM Pressure Safety Point-of-Contact can provide information to the specifying engineer in some cases.

C. Virgin Teflon material exhibits poor cold flow and creep properties for gaskets, and the use of gaskets made from un-reinforced Teflon should be avoided. Reinforced Teflon is a Teflon material in which some fiber, weave, braid, etc. is mixed or sandwiched in the Teflon to provide better strength and cold flow properties.

D. Effects of ionizing radiation must be considered in radioactive services or environments.

   a. A general rule for elastomers used for sealing is that an accumulated radiation dose of 10^6 rads represents the point at which elastomers may be losing their ability to maintain a seal, particularly in a dynamic application where resiliency is required. Radioactive gas (e.g., tritium) that can diffuse into seal materials can accelerate damage rates.

   b. Materials containing polytetrafluoroethylene (PTFE) or trade name Teflon™ have significantly lower thresholds to radiation damage. A dosage of 1.7×10^4 rads causes substantial damage. Common trade and commercial names of PTFE-like materials include: Algoflon, Duroid, Fluon, Fluorocomp, Gortex, Halon TFE, Kalrez perfluoroelastomer, Kel-F polychlorotrifluoroethylene, Neoflon, Polycomp, Polyflon and Teflon.

   c. When radiation exposure can be adequately predicted and controlled below threshold damage levels, select a polymer based on expected environmental conditions including dose. Polymers with relatively higher radiation resistance include Vespel polyimide, Ultra-High-Molecular-Weight Polyethylene (UHMWPE), Ethylene Propylene Diene Monomer (EPDM), and PEEK (Polyetheretheracetone).

Specific Notes:

1) Graphite gasket material may be suitable for much higher pressures and temperatures depending on the specific fluid service (i.e. chemical properties of the service fluid). Consult the ESM Pressure Safety Point-of-Contact for specifics.

2) Reinforced Teflon may be suitable for higher pressures and/or lower temperatures depending on the formulation of the Teflon and the reinforcement material used.

3) Use of aramid fiber gasketing should be avoided in steam service.

4) Metal reinforced Teflon is limited to 392°F.

5) PTFE and RTFE shall not be used in High Level Waste Transfer Systems or similar system in which high dose will damage the material and changeout is difficult.

General Guidance - Non-metals

The following is a brief description of some of the common types of seating and packing materials, and their general use.

PTFE

Virgin Teflon polymer. PTFE has good temperature, chemical, and anti-friction properties. It is inert to most chemical attack, but is affected by liquid alkalis, fluorine, and radiation. It can cold flow under high stress. Maximum 1 x 10^4 RADS lifetime dose. PTFE shall not be used in High Level Waste Transfer Systems.

RTFE

Reinforced Teflon - PTFE reinforced with added fillers, usually fiberglass. The filler provides a higher resistance to cold flow, and allows larger application range. There is a slight increase in friction. Maximum 1 x 10^4 RADS lifetime dose. RTFE shall not be used in High Level Waste Transfer Systems.

UHMWP

Ultra High Molecular Weight Polyethylene. UHMWP is a thermoplastic polymer with exceptionally high notched impact strength, and resistance to stress cracking and abrasion. It has good resistance to most chemicals, but is not recommended for strong acids and organic solvents. It offers higher resistance to radiation than PTFE. Maximum 2 x 10^7 RADS lifetime dose.

TEFZEL

TEFZEL fluoropolymer is a thermoplastic in the same family as PTFE, but is more radiation resistant. Maximum 2 x 10^7 RADS lifetime dose.

PEEK

Polyetheretherketone offers increased steam handling capabilities, and have generally higher the temperature ratings. It has good corrosion resistance, and excellent resistance to radiation. Maximum 1 x 10^9 RADS lifetime dose.

FEP

A melt-processable PTFE with essentially those same properties.

DELRIN

DELRIN is another polymer that is used at higher pressures, and also has higher resistance to radiation than PTFE. Maximum 1 x 10^6 RADS lifetime dose.

NITRILE (NBR, BUNA-N)

Used for low aromatic petroleum solvents, fuels and oils, water, air, and inactive gases.

VITON

Used in high aromatic and halogenated solvents and fuels. Also used in low pressure steam and strong mineral acids.

EPDM

Used for resistance to ozone, weathering, and heat. It has poor resistance to oils, hydrocarbons, alcohols, and radiation.

General Guidance - Metals

The following is a brief description of some of the common metals used in valve construction, and their general use.

CAST IRONS

Generally used in low hazard services (e.g. water or oil). Cast irons have a low cost and are readily available. Disadvantages - no weld end valves, generally poor corrosion resistance, and code limitations.

BRONZE

Generally used in low hazard services (e.g. water or oil). Bronze alloys have a low cost and are readily available. They can have better corrosion resistance than Carbon Steel in some water services. Disadvantages - limited welding.

CARBON STEEL

Carbon steels are the standard selection for many services where corrosion resistance is not critical. It has a relatively low cost and is readily available. Disadvantages - generally poor corrosion resistance.

TYPE 304(L)

SS Austenitic stainless steels are used for their high resistance to oxidation and sulfidation, and where general resistance to corrosion is desired. They are also used widely for cryogenic services. Disadvantages - susceptibility to certain specific corrosion processes (e.g. stress corrosion cracking and intergranular corrosion) in certain media. Type 304(L) is generally a special order valve material, and has been replaced as the "standard" stainless steel material with type 316(L).

TYPE 316(L)

SS Austenitic stainless steels are used for their high resistance to oxidation and sulfidation, and where general resistance to corrosion is desired. They are also used widely for cryogenic services. Type 316(L) has a better resistance to attack by reducing agents, and lower susceptibility to pitting than type 304(L). Disadvantages - susceptibility to certain specific corrosion processes (e.g. stress corrosion cracking and intergranular corrosion) in certain media.

ALLOY 20

Alloy 20 was developed to provide resistance to sulfuric acid over a wide range of concentrations and temperatures. It has good corrosion resistance to other media as well, and is widely used for handling caustic soda, organic acids, chlorinated hydrocarbons, sludge acids, etc. Disadvantage -- cost.

MONEL

Monel provides excellent resistance to sea water, and good resistance to aqueous sulfide and caustic. It is resistant to chloride stress corrosion cracking. It is widely used for handling alkalis, salt water, organic intermediates, and many air-free acids. Disadvantages -- poor resistance to sulfidation above 400°F, and embrittled by sulfur and heavy metals at low concentrations during welding or heating. Corroded rapidly by ammonia and compounds.

INCONEL

Inconel is generally used for handling corrosive media at elevated temperatures. It provides good general corrosion and oxidation resistance, good elevated temperature strength, good resistance to chloride stress corrosion cracking, and excellent corrosion resistance to caustic. Disadvantages - poor sulfidation resistance above 1000°F creates working and welding problems, vulnerable to sensitization and intergranular cracking in some services, and cost.

HASTELLOY B/B2

Hastelloy B provides good resistance to reducing atmospheres at elevated temperatures, and is very resistant to stress corrosion cracking. It is also used for handling hydrochloric acid vapor and varied concentrations of hot sulfuric, hydrochloric, and phosphoric acids. Disadvantages - cost, availability, sensitizes, and can be vulnerable to intergranular corrosion in many services.

HASTELLOY C/C276

Hastalloy C provides good resistance to hypo-chlorites and other solutions containing free chlorine in considerable concentrations. It is also used for handling both oxidizing and reducing chemicals, and is very resistant to stress corrosion cracking. Disadvantages–cost,availability.

APPENDIX D – VALVE SELECTION GUIDE

Introduction

This Appendix addresses proper selection and specification of manual valves and check valves for use in ASME B31.3 systems. This information may be used for guidance in the selection of valves for use in services covered by other piping codes at the discretion of the cognizant engineer. This Appendix does not give absolute direction for the selection of specific valves for specific services. Final selection of a valve and determination of acceptability must be made by the appropriate engineering organization.

Initial selection of valves for any process or service is an engineering decision. Consideration should be given to the required materials of manufacture (body, seats, stem, packing, etc.), type of valve required, fluid sealing requirements, flow throttling requirements, potential transient concerns, etc. Selection of different types of valves can result in extremely different system response to valve action.

References

- ASME B31.3, Process Piping
- ASME B31.1, Power Piping
- *Lyons' Valve Designer's Handbook*, 1982, by Jerry L. Lyons
- *Valve Selection Handbook*, 2nd edition, by R. W. Zappe

Acronyms and Definitions

The following acronyms and definitions are applicable to this Guide. They may either appear in this Guide, or in various vendor valve catalogs. Understanding of these acronyms and what they mean may be necessary to proper valve selection.

<u>ASME</u>: The American Society of Mechanical Engineers.

<u>API</u>: The American Petroleum Institute.

<u>MSS</u>: The Manufacturers Standardization Society of the Valves and Fittings Industry, Inc.

<u>AWWA</u>: The American Water Works Association

<u>CWP</u>: Cold Working Pressure. Refers to the ambient temperature rating of a valve that is normally understood to be -20°F to 100°F. May also be identified as:

<u>WOG</u> (Water, Oil, Gas pressure)

<u>WO</u> (Water, Oil pressure)

<u>OWG</u> (Oil, Water, Gas pressure)

<u>GLP</u> (Gas, Liquid pressure)

<u>WWP</u> (Working Water Pressure)

<u>W</u> (Water pressure).

These markings are typically applied to Bronze and Iron valves. Refer to the applicable standard governing the manufacture for more details on the pressure rating.

<u>SWP</u>: Steam Working Pressure. Usually the high temperature rating and may relate to the maximum saturation pressure/temperature that the valve is rated for. May also be identified as:

WSP (Wet Steam Pressure)

SP (Steam Pressure)

S (Steam pressure)

These markings are typically applied to Bronze and Iron valves. Refer to the applicable standard governing the manufacture for more details on the pressure rating.

Class: This refers to the pressure/temperature rating of the valve (e.g. Class 150 which is sometimes incorrectly referred to as 150 lb.) per the applicable standard of manufacture, some of which are identified in Table D-1.

Cv: The flow coefficient sometime identified for valve flow/pressure loss. This value equates to the flow in GPM at 1 psi differential pressure across the valve using 60°F water.

Required National Codes/Standards Conformance

When used in ASME B31.3 systems, valves are required to be manufactured and tested in accordance with listed standards or they must be qualified as "unlisted" components. Other national consensus standards for piping systems have similar requirements. Table D-1 identifies the standards related to valve manufacture that are accepted as "listed" standards for use in ASME B31.3 systems. Valves that do not conform to one of these standards may be used provided that the ASME B31.3 requirements for qualification of unlisted components is met (refer to paragraph 304.7.2 of ASME B31.3).

Table D-1 Standards for Valves

Standard	Title
ASME B16.34	Valves - Flanged, Threaded, and Welding End
API 594	Check Valves: Flanged, Lug, Wafer, and Butt-welding
API 599	Metal Plug Valve – Flanged, Threaded and Welding Ends
API 600	Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets
API 602	Steel Gate, Globe, and Check Valves for Sizes NPS 4 (DN 100) and Smaller for the Petroleum and Natural Gas Industries
API 603	Corrosion-resistant, Bolted Bonnet Gate Valves—Flanged and Butt-welding Ends
API 608	Metal Ball Valves – Flanged, Threaded, and Welding Ends
API 609	Butterfly Valves: Double-flanged, Lug and Wafer-Type
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C504	Rubber Seated Butterfly Valves
MSS SP-42 (Note 1)	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
MSS SP-67 (Note 1)	Butterfly Valves
MSS SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-81	Stainless Steel, or Stainless-Steel Lined, Bonnetless, Knife Gate Valves with Flanged Ends
MSS SP-85	Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-88	Diaphragm Valves

Note 1: These valves are acceptable even though not listed in Table 326.1 of ASME B31.3. They are listed in Table 126.1 of ASME B31.1. The additional requirements of ASME B31.1 must be met in that "only valves designed such that the valve stem is retained by an assembly which functions independently of the stem seal retainer shall be used" (refer to paragraph 107.1(D) of ASME B31.1).

Selection of Valve Type

One of the principal decisions in valve selection is valve type. Selection of the proper valve type should be based on service experience that demonstrates a particular valve type performs well in a particular service. Manufacturers and operating facilities are good sources of information in this respect. Some general guidance for selection of valve type is provided herein, and is available from various reference materials. Table D-2 provides some general service descriptions and the type of valve commonly selected for those services as indicated in Reference Lyons. Table D-3 provides similar information as identified in Reference Zappe. This information should not be viewed as absolute, nor is it intended to exclude certain types of valves from any services. Decisions of this nature are left to the cognizant engineer. Manufacturer's recommendations may be very helpful in this regard as well.

Table D-2 Valve Selection

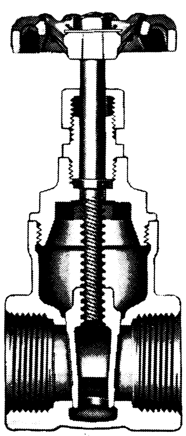
Service	Description of Service	Recommended Valve
Contamination	Control of fluids which may cause contamination buildup, a valve with minimum obstruction to flow is needed	Ball, Gate, Globe, or Pinch
High Pressure	Control of flow at high pressures - selection of a valve to be used in a high pressure application, particularly pneumatic, should be approached with caution	Ball or Globe, Poppet Valves are occasionally used
High Temperature	Control of flow at high temperatures	Ball or Globe, Poppet Valves are occasionally used
Low Leakage	Control of flow with very low seat leakage in the closed position	Ball, Gate, Globe, or Plug
Shutoff	Normal on-off control	Ball, Gate, Globe, or Plug - Ball and Plug Valves normally operate faster
Steam Service	Control of steam under pressure	Ball or Globe
Throttling	Control the amount of flow by varying the valve position	Globe - Ball and gate valves tend to vibrate under flow, and erosion is a concern when using gate valves

Table D-3 Valve Selection

Valve	Type	Mode of Flow Regulation			Fluid				
						Solids in Suspension			
		On-Off	Throttling	Diverting	Free of Solid	Non-Abrasive	Abrasive	Sticky	Sanitary
Globe	Straight Pattern	Yes	Yes		Yes				
	Angle Pattern	Yes	Yes		Yes	Special	Special		
	Oblique Pattern	Yes	Yes		Yes	Special			
	Multi-Port			Yes	Yes				
	Piston	Yes	Yes		Yes	Yes			
Parallel Gate	Conventional	Yes			Yes				
	Conduit	Yes			Yes	Yes	Yes		
	Knife	Yes	Special		Yes	Yes	Yes		
Wedge Gate	With bottom Cavity	Yes			Yes				
	Without Bottom Cavity (rubber seated)	Yes	Moderate		Yes	Yes			
Plug	Non-lubricated	Yes	Moderate	Yes	Yes	Yes			
	Lubricated	Yes		Yes	Yes	Yes	Yes		Yes
	Eccentric Plug	Yes	Moderate	Yes	Yes	Yes		Yes	
	Lift Plug	Yes		Yes	Yes	Yes		Yes	
Ball	---	Yes	Moderate	Yes	Yes	Yes			
Butterfly	---	Yes	Yes	Special	Yes	Yes			Yes
Pinch	---	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Diaphragm	Weir Type	Yes	Yes		Yes	Yes		Yes	Yes
	Straight Through	Yes	Moderate		Yes	Yes		Yes	Yes

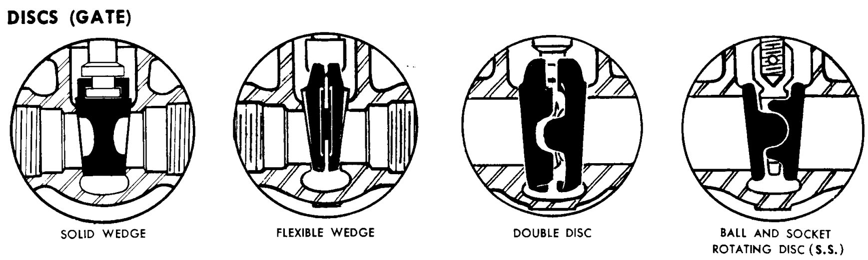
Additional information on some of the more common valve types is provided in the following paragraphs. Typical applications and some common problems that may be helpful in the selection of the proper valve are discussed, as well as a brief description of some common valve types. Other valve types such as pinch valves, and diaphragm valves are less common, and thus not described. However, these types of valves may be selected at the discretion of the cognizant engineer.

Gate Valves



Gate valves are the most common type of valve used in industrial applications. It functions by inserting a disc across the flow path. Gate valves may be used in systems where flow direction varies and can be reversed as this valve type is "bi-directional," i.e. valve operation and flow characteristics are the same for either direction of flow. Gate valves should be used in the wide open or fully closed position only, as this valve type is usually not suitable for throttling service. Having very little resistance to flow, it is ideal for conditions where the pressure drop is critical.

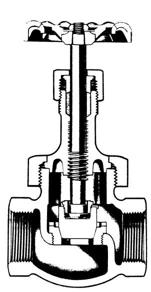
Some examples of available disc designs for gate valves are shown in the following figure. All of the disc designs are used for the same type services, except that the solid wedge disc designs are not suited for applications with large variations in temperatures. Note that the "double disc" gate valve is sometimes referred to as a "split disc" gate valve.



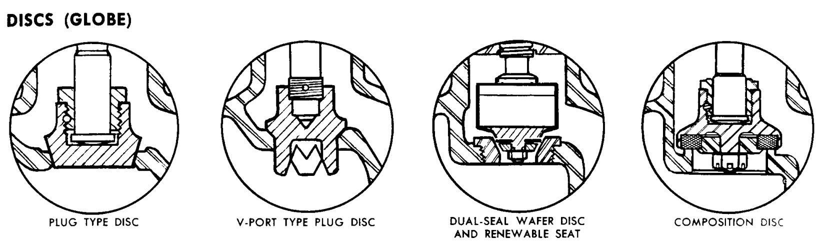
Some of the disadvantages of a gate valve are as follows:

1) The full stem travel requires many turns of a handwheel and many more turns when fitted with gearing.
2) Due to the long stroke and the outside appurtenances necessary to accommodate this stroke, a longer space envelope (over-all length) is required.
3) Body seat surfaces for gate valves are more difficult to machine or refinish.
4) Very little or slow movement of the disc near the full closed position causes high velocity flow, resulting in galling of the sliding parts and scoring of the seating surfaces (often called “wire drawing”).
5) Solid wedge type gate valves have a generic problem called “thermal binding.” This condition occurs when a valve is closed tightly while the high temperature system it is located in is still in operation. Subsequently, the system is shut down, and cooldown takes place. Because of the internal design of a wedge gate valve, the seats move inward at an amount greater than the wedge shrinkage occurring during cooldown. The difference in thermal contraction can bind the wedge tight enough so that it cannot be reopened until the system temperature is raised enough to reheat the valve.
6) Solid wedge gate valves in systems where severe temperature changes occur are also subject to excessive seat leakage due to changes in angular relationship between the wedge and the seat faces due to pipe loads exerted on the valve ends.
7) Metal-seated gate valves should not be used for air or gas service because they do not have the bubble-tight closure necessary for these services.

Globe Valves



Globe valves are also very commonly used in industrial applications. The globe valve controls flow by lifting or lowering a circular disc on a seat designed to accept the contour of the disc. Globe valves are commonly used as throttling valves as well as stop valves. The throttling capability of the valve is very dependent on the design of the disc. In most cases, discs furnished are of the “quick-opening” or “semi-throttle” designs, which do not provide for very accurate throttling. If additional throttling is required, other disc forms are available on special order, such as the “linear” and “equal percentage” designs, which provide much better throttling characteristics. These characteristics of the valve operation may be important if the valve is required for throttling service. Globe valves can be used in gas applications and provide "bubble-tight" closure if the discs are furnished with resilient inserts. Some examples of typical globe valves disc designs are shown in the following figure. Note that the V-Port type Plug Disc is usually intended for fine throttling applications, and the other discs fall into the quick-opening or semi-throttle category.



The globe valve has historically been used primarily for throttling service. In some cases where system flow can reverse, the globe valve has been used as a stop valve (where the pressure is acting on top of the disc and tending to force the valve closed). Small globe valves 2 inches and smaller may be used as stop valves because the force under the disc is within the capability of the stem threads to keep the valve closed. In throttling service (being partially opened the majority of the time), the valves must be equipped with deep stuffing boxes, and the disc should be guided along full travel.

Additionally, globe valves are used for services requiring frequent operation and positive shutoff.

The maximum differential pressure across the valve should not exceed 20 percent of the upstream line pressure and never exceed 200 psi, unless a special trim and disc design is provided by the manufacturer.

Small globe valves can be used as piping or equipment high point vent or low point drain connections as well as root valves for instrument pressure connections. Globe valves with special trim are used for blowoff or blowdown system applications.

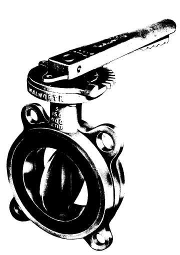
Globe valves are available in various body configurations. Some advantages of these different configurations are:

1) Tee Pattern (standard): When severe throttling is required as in a bypass line around a control valve where pressure drop is not a concern. This pattern has the lowest Cv.

2) Wye Pattern: When valve is normally wide open and throttling during seasonal or startup operations is required. This valve type has very little resistance to flow and can be "cracked open" for long periods without severe erosion.

3) Angle Pattern: Similar in application to the wye pattern globe with a slightly lower Cv. A particularly good selection for systems that have periods of pulsating flow because this valve configuration adequately handles the "slugging" effect inherent with this type of flow.

Butterfly Valves



The butterfly valve (also called a trunnion valve) is a quarter turn valve that rotates a disc in the flow stream. These valves were originally intended to be lightweight, non-leaktight seating dampers. Many varieties of this valve are still intended for this "non-leaktight sealing" service, however design improvements in high performance butterfly valves have produced some which are acceptable for high pressure, high temperature service with bubble tight closure.

Butterfly valves are generally used as stop valves for throttling purposes in water systems. In particular large diameter piping systems of ANSI Classes 150 and 300 with resilient seating materials and much higher class ratings for metal seating materials are poorly suited for stop valve service. Smaller butterfly valves are used in piping arrangements where space limitations dictate their use over dimensionally long valve types.

In addition to the price advantage in the large sizes, the butterfly valve also has a definite weight advantage. The following is a typical weight comparison when using an ANSI Class 150 wafer style butterfly valve:

Butterfly = 53 lbs.

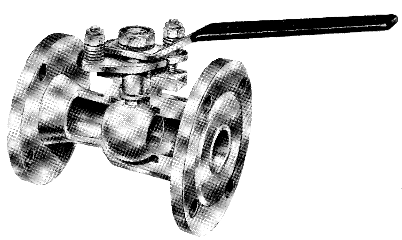
Ball = 158 lbs.

Gate = 310 lbs.

Butterfly valves fall into the category of "flow sensitive valves" because the disc movement is unguided and their operability is affected by incoming turbulence. Close proximity of the butterfly valve to certain piping components can amplify the normal dynamic reactions. For example, the velocity profile of the discharge of a pump is not symmetrical. When installed at the discharge of a centrifugal pump with a vertical shaft, the result can be fluid dynamic torques that are twice the magnitude of those found for a valve with straight run of pipe upstream. The eccentric forces applied to the valve disc produces excessive vibration and "disc flutter" which eventually results in a complete breakdown of the valve.

Butterfly valves may be used for throttling service. However, in throttling applications, the major concern for the valves is cavitation. The recommended range of flow control is between the 30° and 80° disc opening, although throttling operations require individual study. Acceptability of throttling performance may also depend on the location of the valve in a piping run and whether the valve has a free discharge or discharges into a closed system.

Ball Valves



The ball valve is another quarter turn valve, and consists of a highly polished spherical ball with an opening (port) bored through the center. The ball is wedged between two seat rings, which are typically a relatively soft material (Teflon, Viton, EPDM, etc). Valve operation involves rotating the ball to either align the port with the flow stream to open the valve, or aligning the solid portion with the flow stream thereby closing the valve.

All 2-way ball valves furnished with two seat rings are bi-directional; flow entry can be from either end without comprising the function of the valves. However, single seated valves have a "preferred" entry and are therefore classified as "unidirectional." Another condition that makes a ball valve unidirectional is when the valves are furnished in the 3-way, 4-way, or 5-way designs where flow must enter a designated port in order to divert the flow toward the established direction. Because of the complicated machining process within the ball discs for multiport ball valves, sharper turns are necessary so resistance to flow is a necessary result when compared to the traditional 2-way valve.

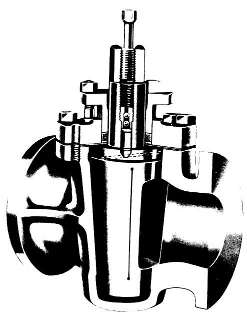
Ball valves are used as bubble-tight stop valves for relatively clean fluid systems, such as air, water, and gas. The popularity of this valve is enhanced by its very small space envelope for a given line size and its quarter turn operation from the closed to open position.

The multiport ball valve is used frequently for diverting flows to several directions using a single valve. In addition, the valve (manually actuated) has a very low center of gravity and is constructed of a very simplified design. With its few moving, and accessible parts, this valve design rates very high with respect to maintenance costs. The temperature limitations for the various seat and seal materials give a wide range of service temperature conditions that can be accommodated. Standard ball valves should not be used for any sustained throttling (over 2 hours at a maximum differential pressure of 50 psi) as severe erosion of the ball and seat ring may result. However, several manufacturers have specific ball valve designs that are intended for throttling service.

The ball valve has a generic design problem that exists when suspended solid particles in the fluid system (resins, oxide particles, etc.) settle-out and become trapped in the cavities below the ball and in the vicinity of the stem or trunnion areas. This occurs typically when flow has stopped and this “crud” has had time to become encrusted. One solution to this problem is to position all valves mounted in a horizontal run of pipe so that the stems or turnings are on the horizontal. This valve position will promote the “self-scouring “ motion when flow returns.

Multiport ball valves can provide the function of two or more valves when used in systems where flows are frequently diverted to various directions. The flow inlet and outlet ports designated by the manufacturer should not be altered to avoid “by-passing” between ports.

Plug Valves



The plug valve is very similar to the ball valve except that instead of a ball with a port, a cylindrical plug with an elliptical or round port is used. Plug valves are used as bubble-tight, on-off stop valves in a variety of fluid systems, including air, gas, oil or oil mixtures, and liquid slurries.

Due to the fact that the plug sealing methods do not promote “crud traps” or internal pockets where deposits could accumulate, plug valves have functioned successfully with dust, dirt, or other gritty contaminants suspended in the above systems.

The unique quality of this valve, to be “self cleaning” by automatically “wiping off” accumulated deposits in the closed position as the plug is rotated, makes this valve highly recommendable for contaminated systems.

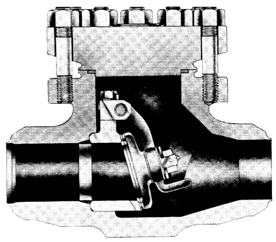
Plug sealing is accomplished using one of two methods: (1) a sealant forced into machined passages around the valve ports, and (2) a resilient liner or sleeve into which the machined tapered plug is forced. The sealant also acts as a lubricant and can typically be used in systems whose service temperature is as high as 650 F. The resilient material (usually an elastomer) is limited by the temperature rating of the sleeve material. In systems such a demineralized water, where conductivity is monitored and should not be exposed to contaminants, the lubricated plug valve should not be used.

Throttling service should not be the primary function of a plug valve. However, if throttling accuracy is not important, non-lubricated plug valves may be used if the valve is equipped with a device to hold the plug to a “set” position and prevent “drifting” to the closed position. Lubricated plug valves should not be used for throttling because the sealant grooves adjacent to the port opening would be exposed to the flow stream and a considerable amount of sealant would be “washed away” by the system fluid velocity. Cylindrical plug valves, particularly those with round ports, are not produced by many manufacturers so the justification for selection of this type of valve must be based upon specific system requirements.

Check Valves

The check valve operates automatically to pass flow in one direction, and prevent any reversal of flow. The valves typically give no indication of setting, or warning of its condition. These valves are also referred to as non-return valves, and are not usually intended to provide a tight shutoff function. There are numerous check valves types and configurations. Some of the more common types include: the swing check, the lift check, the tilting disc check, the folding disc check, and the stop check. Different services may require different types of check valves. It is important to consider the required velocity to fully open the check valve, closure time on flow reversal, and other operating characteristics when selecting a check valve. Much of this information is specific to a particular valve and is available only from the manufacturer.

5.6.1 SWING CHECK



The swing check valve is widely used because most system flow conditions (velocity and pressure) are within the acceptable range recommended for this valve. Body configurations are available in Tee, inclined or Wye, and wafer styles. The majority of these valves have "swings" or hinges near the top of the valves or near the access point. Swing check valves typically (except for wafer types) have top access to the valve internals for replacement of parts or seat refinishing.

Seat materials vary for swing check valves and are dependent on service requirements. Seating may be metal-to-metal or metal to resilient material, and may be either integral or replaceable. Seating angles vary from 0° to 45° and serve two purposes:

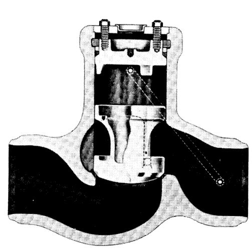
1) The length of disc travel is reduced with a higher seat angle. Thus, the danger of water hammer may also be reduced with a quicker closing disc.

372 When swing check valves with a vertical seat (0° angle) are located in horizontal runs of piping, slight slopes may cause the valve to hang open. A seat angle of 5° to 7° can typically correct for this.

The seating surfaces have a broad contact area due to the problem of seat alignment. The swing disc is unguided along its full travel and depends on a hinged action that must maintain relatively loose tolerances to accomplish, at best, a fair leak tight seating. The looseness provided at the disc connection to its holder or pivot arm allows the disc to rotate under turbulent flow. This rotation has contributed to some cases of discs separating from their holders. The engineer may need to place special emphasis on the disc connection details of the holder and method of fastening.

It is important that the service conditions ensure the disc remains in its full open position to prevent disc flutter that can damage the valve. Swing check valves have a tendency to "slam" shut on flow reversal. This shortens the life and leak tightness of the seating surfaces. Some manufacturers offer options such as an outside lever to control the travel time of the disc.

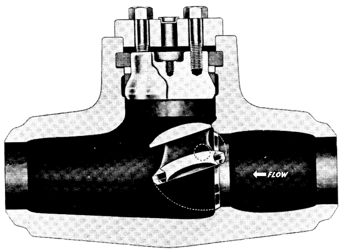
LIFT CHECK



The lift check is another widely used check valve. It is more versatile than the swing check in that some designs will adapt to pulsating flows and, in general, can be used in higher velocity systems. The seating arrangement is similar to that of the globe valve with fully guided disc travel and point contact seating surface interface, which results in better leak tightness than the swing check.

Body configurations are similar to those of globe valves with similar loss characteristics. Lift check discs are available in the form of a piston (or poppet) and a ball. The ball lift check is typically used for highly viscous fluids where low velocities do not cause excessive ball rotation.

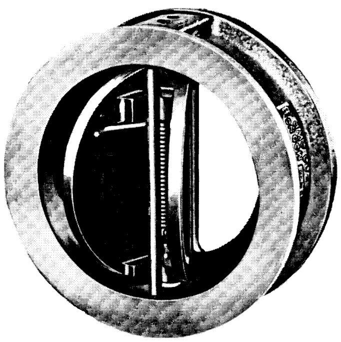
TILTING DISC CHECK



The tilting disc check valve was intended to provide a compromise between the swing check and the lift check. The main features of this valve are a reduction in the slamming effect of the disc on flow reversal and a very short length of travel that results in a quick closing valve.

This type of check valve typically provides access to the internals for maintenance.

FOLDING DISC CHECK



The folding disc check valve (also referred to as the split disc check) utilizes a disc that folds in the middle of the flow stream to permit flow. This type of check valve is used for its space savings features and its quick closing capability. These valves are available from a relatively limited number of manufacturers compared to other types of check valves. It can be mounted in almost any position because it uses a positive force (typically a spring) to provide the closing force.

These valves have many seating material options both in the resilient type or metal to metal type, and are manufactured for various services including air or gas. One good feature of the folding check valve is that there are no internal fasteners to become loosened and cause a breakdown in the valve function.

STOP CHECK

The stop check valve combines the normal free operating functions of a check valve, with the additional capability of providing a temporary stop valve function. To accomplish this they are fitted with a screw-down stem that is not fastened to the disc, but can hold the disc in the closed position. These valves are manufactured either as swing checks or piston lift checks.

These valves must be furnished with a bonnet to contain the stuffing box necessary to provide a dynamic seal around the stem. This necessitates additional material considerations for stem, packing, etc.

Materials

Selection of the proper materials to resist degradation to the desired service conditions is crucial in the selection of the proper valve. This can be a very simple decision for services such as low pressure/temperature air and water, or a very difficult decision for more severe services such as radioactive wastes and hazardous chemical solutions. Resistance of various metals, elastomers, and packing materials to chemical attack can be found in various valve manufacturer catalogs and material handbooks. Some guidance for selection of valves for common fluid services is also provided in Appendix B. See Appendix C for additional discussion on materials selection.

Procurement Level

A graded approach to valve procurement is the responsibility of the cognizant engineering organization based upon the service requirements, level of quality assurance required, and the functional classification of the service. Where specific materials are not crucial to the service, and the service is not safety related, lower levels of quality assurance may be acceptable. Where specific materials are required for the correct functioning of the system, quality control checks at receipt inspection should be considered as a minimum. It should also be noted that, for ASME B31.3 systems, material verification in accordance with ASME B31.3 is required (at the percentages noted in that code), and procurement requirements or receipt inspection has no relation to this requirement.

Valve Specifications

The valve style numbering system provided below was developed to provide the cognizant engineer with a convenient method of identifying the desired features in valve procurements. The style number system provides a method of alpha-numeric identification of valves and should be used for identifying valves on the design drawings and/or Bills of Material. This system should be used in addition to the unique component numbering system required by ESM Chapter 1, Section 230, Component Nomenclature.

The following page provides a description of the numbering scheme for the valve specifications. The following **general notes** are applicable to all of the valve specifications:

1) Desired features that are required by the engineering design but not identified in the style valve number must be noted in the procurement documents and on the applicable design drawings

2) Not all possible combinations of materials are necessarily available. Some combinations may require extensive lead times and high cost. The purchaser should take care to specify only what is required by design, and should consult available manufacturers to decide between acceptable options on the basis of what may be readily available.

3) Acceptance of valves that do not specifically conform to all requirements of one of the listed standards (Table D-1) is at the discretion of the cognizant engineer, and may required additional qualification to comply with the applicable piping code (e.g. qualification as an unlisted component per ASME B31.3).

4) Valve materials identified are those that are commonly available. Other materials may be available, and material availability changes over time with the advent of new and better materials. The valve style numbering system is controlled by the ESM Pressure Safety Point-of-Contact, and consideration will be given to any additions required by specific facilities on a case by case basis.

5) For austenitic stainless steel valves with welded ends (socket weld or butt weld), the low carbon alloys are required (e.g. F304L, CF3, F316L, or CF3M).

NOTES:

1-ASTM A216 WCB or A105
2-CF3, CF8, F304, or F304L
3-CF3M, CF8M, F316, or F316L
4-Use only in copper piping systems.
5-Includes Swagelok and Parker tube fittings.
6-Includes NBR and Buna-N.
7-Use only non-asbestos.
8-Non welded end stainless steel valves pressure rating is based on the high carbon (non L) grade.
9-Specify port requirement.

EXAMPLE VALVE STYLE NUMBER:

CV 1 0 1 GW - # - A B C D E
1 2 3 4 5 6 7 8 9 10 11

1-Acceptable Standards - LANL Valve
2- Basic Material (Body Material)
3-Pressure Class
4-Type of End Connection
5-Type of Valve
6-Valve Size
7-Disc or Ball Material (optional)
8-Seat Material (optional)
9-Stem Material (optional)
10-Packing Material (optional)
11-Body Gasket Material (optional)

REQUIRED SPECIFICATION FEATURES

1) Acceptable Standards	2) Basic Material	3) Pressure Class (8)	4) End Connection	5) Type of Valve
CV Code Valve	1 Brass	0 125	1 Flanged	BL Ball
NV Non Code Valve	2 Bronze	1 150	2 Socket Weld	BT Butterfly
	3 Iron (Cast/Ductile)	2 200	3 Butt Weld	CB Ball Check
	4 Carbon Steel (1)	3 300	4 Threaded	CF Folding Disc Check
	5 Stainless Steel 304/304L (2)	4 400	5 Wafer	CL Tilting Disc Check
	6 Stainless Steel 316/316L (3)	6 600	6 Solder (4)	CP Poppet Check
	7 Monel	8 800	7 Flare	CS Swing Check
	8 Alloy 20	9 900	8 Mechanical	CT Tilting Disc Check
	9 Hastelloy	P Pressure Rated	9 Compression (5)	DV Diaphram
	E Engineered Procurement		E Engineered Procurement	GF Gate:Flex./Wedge/Split Disc
				GK Knife Gate
				GP Parallel Gate
				GW Solid Wedge Gate
				PI Pinch
				PV Plug
				SC Stop Check
				TA Angle Globe
				TN Needle Globe
				TS Standard Globe
				TY Y Pattern Globe
				V3 Three Way (9)

OPTIONAL SPECIFICATION FEATURES

7) Disc Material	8) Seat Material	9) Stem Material	10) Packing Material	11) Body Gasket
A Chromium (11-13%)	A Chromium (11-13%)	A Chromium (11-13%)	A Graphite	A Graphite
B Stellite (Hard Face)	B Stellite (Hard Face)	B Carbon Steel	B Teflon	B Teflon
C Bronze	C Bronze	C Bronze	C Natural Rubber	C Natural Rubber
D Stainless Steel	D Stainless Steel	D Stainless Steel	D Nylon	D Nylon
E Monel	E Monel	F Alloy 20	E Nitrile (6)	E Nitrile (6)
F Alloy 20	F Alloy 20	G Hastelloy	F Neoprene	F Neoprene
G Hastelloy	G Hastelloy	H Brass	G Viton	G Viton
H Brass	H Brass	I Nickel Copper	H EPDM	H EPDM
I Nickel Copper	I Nickel Copper	S Special (Specify)	R UHMWPE	I Ferrous
J Teflon	J Teflon	X No Specifc Requirement (7)	S Special (Specify)	J Non-Ferrous
K Natural Rubber	K Natural Rubber		X No Specifc Requirement (7)	K Spiral Wound w/Teflon
L Nylon	L Nylon			L Spiral Wound w/Graphite
M Nitrile (6)	M Nitrile (6)			R UHMWPE
N Neoprene	N Neoprene			S Special (Specify)

O Viton	O Viton	X No Specific Requirement (7)
P EPDM	P EPDM	
Q Vespel	Q Vespel	
S Special (Specify)	R UHMWPE	
X No Specific Requirement (7)	S Special (Specify)	
	X No Specifc Requirement (7)	

Replacement of Existing Valves

It is important to remember selection of the proper valve for a particular service is an engineering decision, and replacement of existing valves should be with a new valve that has all of the features required by the design. If the specific features that the cognizant engineer originally required are not known, replacement should be in kind unless the valve did not perform satisfactorily.

Replacement of a valve that did not perform acceptably in a given service is the responsibility of the cognizant engineer. The cause of the unsuitability of the valve (e.g. material compatibility, functional problem, etc.) should be determined before a replacement valve is specified.

APPENDIX E – FLANGED CONNECTIONS

Introduction

The guidance provided by this appendix is based on ASME B16.5 flanges. The majority of this guidance is representative of "good practices" that applies to the installation of many types of pipe flanges. Torque values presented herein are based on ASME B16.5 flanges and should be confirmed by engineering prior to use with other flanges.

Many factors can affect the ability of a flanged joint to establish an initial seal and maintain that seal during service for an extended period of time. One of the most important considerations is proper flange installation. The following guidance is provided to ensure that flanges are installed correctly either during initial installation or during maintenance activities.

ASME B31.3 recognizes a variety of national flange standards as "listed" components, including the following:

ASME 16.1 "*Grau Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250* "

ASME 16.5 "*Pipe Flanges and Flanged Fittings,*"

ASME B16.36 "*Orifice Flanges*,"

ASME B16.42 "*Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300,"*

ASME B16.47 "*Large Diameter Steel Flanges, NPS 26 Through NPS 60,*"

AWWA C207 "*Steel Pipe Flange for Waterworks Service,"*

MSS SP-44 "*Steel Pipeline Flanges,*" and

MSS SP-51 "*Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings."*

Pre-Assembly

Prior to assembly ensure that the following actions are completed.

1) Fastener materials shall be free of nicks, burrs, chips, dirt, and damage (inspect threads, shank, and nuts). All damaged fasteners must be replaced.

2) Flange faces (both raised and flat) must also be clean and free of debris or foreign material. Imperfections such as nicks, dents or gouges will affect the gasket's ability to seal. The following table may be used to determine the allowable size of imperfections for ASME B16.5 flanges. Multiple imperfections must be separated by at least four times the permissible radial projection, and no protrusions above the serrations are permitted. For smooth flange faces, the right hand column values should be used. The applicability of this criteria to other types of flanges should be evaluated on a case by case basis.

TABLE 1 - Permissible Imperfections

NPS	Maximum Radial Projection of Imperfections Which are No Deeper Than the Bottom of the Serrations	Maximum Depth and Radial Projection of Imperfections Which Are Deeper Than the Bottom of the Serrations
½ " through 2 ½ "	0.12"	0.06"
3"	0.18"	0.06"
4" through 6"	0.25"	0.12"
8" through 14"	0.31"	0.18"
16"	0.38"	0.18"
18" through 24"	0.50"	0.25"

3) Gaskets used in ASME B16.5 flanges must satisfy the requirements of ASME B16.20a for metallic gaskets and ASME B16.21 for non-metallic flat gaskets. Gaskets used in ASME B16.1 flanges must comply with ASME B16.21. Table 2 provides groups different gasket types to be used for the selection of torque values. Refer to Appendix C for guidance with materials selection.

Table 2 - Gaskets

Group I [1]	Group II	Group III
Nitrile, Neoprene, Viton, EPDM	Reinforced Teflon, Graphite, NBR/Synthetic Fiber, SBR, NBR, or EPDM /aramid Fiber, Spiral Wound - low stress	Spiral Wound w/ any filler material (e.g., Flexitallic style CG)

Notes: 1. Group I gaskets should only be used with flat face flanges.

4) With flat sheet non-metallic gaskets, thinner gaskets are preferred (typically 1/16").

5) Ensure that gaskets are of the correct material and size. Gaskets must be clean and not bent, broken, torn or distorted in any manner. The allowable shelf life must be checked.

6) No more than one gasket shall be used between contact faces in assembling a flanged joint.

7) Flange surface finish (roughness) should be compatible with the gasket material. Soft gaskets such as neoprene should have a rough finish (e.g., 250AA) and flat metal gaskets should have a smoother finish (e.g., 32AA). The typical finish provided on B16.5 flanges (i.e., 125μin to 500μin) is normally acceptable for use with gaskets listed in Table 2

8) Use only calibrated torque wrenches and multipliers. Examine the torque wrench for proper calibration, damage, and proper range. Torque wrenches can be used only within the range specified by the wrench manufacturer. Specified working ranges typically vary from 25% - 75% to 20% - 100% of the full torque wrench range.

9) Appropriate calculations must be made when using multipliers, a crows foot, or any other attachment which adds length to the torque wrench (cheater bars are not acceptable).

Assembly

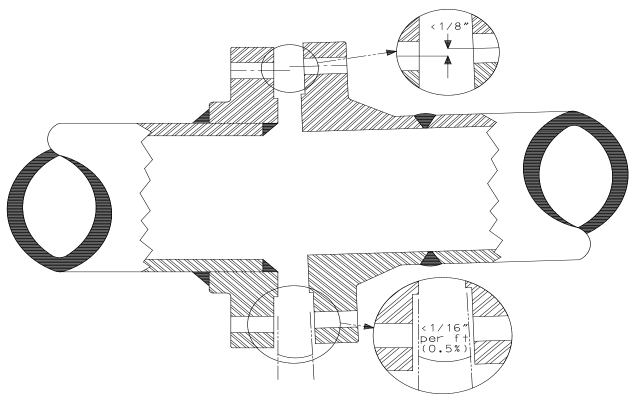
The following instructions provide guidance for proper assemble or re-assembly of a flanged connection.

1) Prior to bolting up, flange faces shall be aligned properly. Ideally, the flange faces should be parallel to within 1/16 in/ft (0.5%) measured across any diameter and the bolt holes shall be aligned within 1/8” maximum offset (ref. Figure 1). Table 3 presents the required alignment for Class 150, 300, and 600 Flanges. The values for Class 600 flanges may be applied to high classes of steel flanges as well.

Table 3 - B31.3 Required Alignment for Class 150 Flanges

Pipe Size (in.)	Allowable Gap (in.)		
	Class 150	Class 300	Class 600
½	0.018	0.020	0.020
¾	0.020	0.024	0.024
1	0.022	0.025	0.025
1 ½	0.026	0.032	0.032
2	0.031	0.034	0.034
3	0.039	0.043	0.043
4	0.049	0.052	0.056
6	0.057	0.065	0.073
8	0.070	0.078	0.086
10	0.083	0.091	0.104

Pipe Size (in.)	Allowable Gap (in.)		
	Class 150	Class 300	Class 600
12	0.099	0.107	0.115



Fiqure 1 - Flange Alignment Requirements per ASME B31.3

2) The proper lubricant shall be used on threads of bolts and nuts. Use low or no chloride content lubricants with stainless steel (e.g., Fel-Pro C-100 Antiseize Compound).

3) Use hardened steel washers and/or lubricate smooth face of nut (i.e., face under compression load). Raised lettering on the nuts must be faced outward.

4) All nuts must be snug tight prior to torquing.

5) Torque values are a function of both the gasket and fastener materials as well as the size and class of flange. Application of the torque values listed in Table 4 ensure that gaskets receive the proper pre-load stress. These torque values are sufficient to seat the listed gasket materials. When significant external mechanical or thermal loads are imposed on a flanged joint, additional evaluation by engineering may be required.

TABLE 4 - RECOMMENDED TORQUE VALUES (ft-lbs)

	GROUP I		GROUP II		GROUP III	
NPS	Torque Class 150 FLAT FACE[1,2]		Torque Class 150 RAISED FACE	Torque Class 300 RAISED FACE	Torque Class 300 RAISED FACE	Torque Class 600 RAISED FACE
½"	10	20	20	20	65[3]	65[3]
¾"	12	22	28	35	130[3]	130[3]
1"	14	26	40[3]	45	130[3]	130[3]
1 ½"	20	35[3]	50[3]	115[4]	225[3]	225[3]
2	35	60	100[3]	75[3]	130[3]	130[3]
2 ½"	45	85[3]	100[3]	105[4]	225[3]	225[3]
3"	50	90[3]	100[3]	135[3]	225[3]	225[3]
4"	35	60[4]	100[3]	190[3]	225[3]	365[3]
6"	50	95	170[3]	190[3]	225[3]	550[3]
8"	70	130[3]	170[3]	305[3]	365[3]	775[5]
10"	75	135	275[3]	330[3]	550[3]	1090[5]
12"	105	190[4]	275[3]	490[3]	775[5]	1190[5]
14"	145	265[4]	410[3]	500[3]	775[5]	1430[5]
16"	130	240	410[3]	700[3]	1090[5]	1900[5]
18"	150	275	585[3]	685[3]	1090[5]	2735[5]
20"	140	260	585[3]	755[3]	1090[5]	2735[5]
24"	195	365	820[3]	1165[3]	1900[5]	4260[5]

Specific Notes:

1) Left column torque values are based on a gasket hardness of Type A Shore durometer < 50. Right column torque values are based on Type A Shore durometer ≥ 50. 2) Not recommended for fluid services that exceed 125 psig. 3) Do not use A193 B8 Class 1 or A307 fasteners. 4) Do not use A193 B8 Class 1 fasteners. 5) Use only A193 B7 fasteners.

General Notes:

- Table is based on ASME 16.5 flanges with properly sized bolts.
- Torque tolerances:
  - ± 2 ft-lbs if torque value is ≤ 50 ft-lbs
  - ± 4 ft-lbs if torque value is ≤ 100 ft-lbs
  - ± 4% of torque value if > 100 ft-lbs.
- For sheet gaskets, torque values can be used for 1/32" through 1/8" thick gaskets.
- Contact engineering for assistance with torque values outside the scope of this table.

6) Table 5 provides the maximum allowable torque values for common bolt materials. These torque values shall not be exceeded. Note that some of these bolt materials are not acceptable for the torque values listed in Table 4. The torque values listed in Table 5 result in a preload stress of 90% of the ASME B31.3 Specified Minimum Yield Strength.

Table 5 - Maximum Allowable Torque Values

	Torque (ft lbs.)					Torque (ft lbs.)			
Bolt Size	**A307**	**B8 cl.1**	**B8 cl.2**	**B7**	**Bolt Size**	**A307**	**B8 cl.1**	**B8 cl.2**	**B7**
½	34	29	95	100	1¼	585	490	1060	1715
5/8	69	57	190	200	13/8	770	640	1070	2250
¾	120	100	335	355	1 ½	1020	850	1420	2985
7/8	195	160	435	570	15/8	1475	1230	-	4305
1	295	245	650	855	1¾	1615	1345	-	4710
11/8	415	345	750	1215	17/8	2300	1915	-	6710

7) Table 6 identified acceptable substitute bolt materials for those identified in Table 4. The maximum allowable torque values for the original material are applicable to the substitute material as well.

Table 6 - Acceptable Substitute Bolt Materials

Material	Substitutes
A193 B8 Class 1	A193 B8T Class 1 A193 B8C Class 1 A193 B8M Class 1 A320 B8 Class 1 A320 B8T Class 1 A320 B8C Class 1 A320 B8M Class 1 Note: Use Type 6 or 6F Nuts
A193 B8 Class 2	A193 B8T Class 2 A193 B8C Class 2 A320 B8 Class 2 A320 B8T Class 2 A320 B8C Class 2 Note: Use Type 8, 8C, 8M, 8T, 8F, 8N, 8P Nuts

8) Other, more accurate, methods of obtaining preload such as bolt tensioners or measurement of bolt elongation may be substituted for torque wrenches if performed in accordance with an approved procedure.

9) Preload of elastomeric gaskets used with other types of flat faced flanges (fiberglass, aluminum, etc.) should be based on an acceptable leak test. In general 20% - 25% compressive deflection of the gasket will place the material in its most favorable sealing condition.

10) The pattern in which bolts are tightened is extremely important. If performed improperly, tightening can cause the flange to move out of parallel. A staggered crisscross-torquing pattern, shown in the following sketch, must be used to tighten the bolts. No more than one third of the final torque should be achieved during a single step.

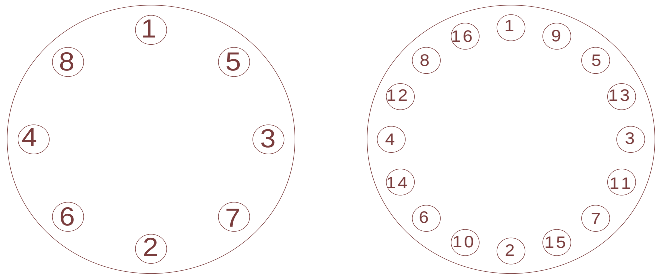


Figure 2 - Typical Torquing Sequences

11) Following the first torquing pass confirm that the flanges are parallel. If flanges are not parallel at this point, make two complete passes around the flange at 1/3 of the specified final torque to equalize load in the fasteners and examine again for parallelism. If the flanges are not parallel and full face contact has not been achieved, engineering must evaluate for excessive misalignment.

12) The following table is based on ASME/ANSI B16.5 and provides fastener information for commonly used flange classes.

TABLE 7 - Flange Fasteners

NPS	Class 150		Class 300		Class 600	
	Bolts (1)	Size	Bolts (1)	Size	Bolts (1)	Size
½”	4	½”	4	½”	4	½”
¾”	4	½”	4	5/8”	4	5/8”
1”	4	½”	4	5/8”	4	5/8”
1 ½”	4	½”	4	¾”	4	¾”
2”	4	5/8”	8	5/8”	8	5/8”
2 ½”	4	5/8”	8	¾”	8	¾”
3”	4	5/8”	8	¾”	8	¾”
4”	8	5/8”	8	¾”	8	7/8”
6”	8	¾”	12	¾”	12	1”
8”	8	¾”	12	7/8”	12	1 1/8”
10”	12	7/8”	16	1”	16	1 ¼”
12”	12	7/8”	16	1 1/8”	20	1 ¼”
14”	12	1”	20	1 1/8”	20	1 3/8”
16”	16	1”	20	1 ¼”	20	1 ½”
18”	16	1 1/8”	24	1 ¼”	20	1 5/8”
20”	20	1 1/8”	24	1 ¼”	24	1 5/8”
24”	20	1 ¼”	24	1 ½”	24	1 7/8”

Notes: 1. Bolts refer to all types of threaded fasteners used in flange joint assembly (ref. section 6.0).

13) When sequential torquing is complete, use rotational and reverse rotational tightening to check that all nuts are stable. Nuts are stable when the torque wrench does not turn before the wrench achieves the final bolt torque value.

14) Nuts shall have full thread engagement on the bolts or studs. One to two exposed threads is the preferable requirement 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.

15) After leak test and system startup, thermal expansion, creep relaxation and fastener thread embedment can change the fasteners’ applied load. Therefore, a re-check of each fastener is

recommended especially for piping systems that have non-metallic gaskets and operate at temperature levels above 200°F.

Disassembly

Prior to disassembly match mark the flange rim (if appropriate) to ensure that the flanges are reinstalled in their original configuration. Ensure that the following tasks are performed following disassembly:

1) Adequate controls are in place to maintain cleanliness.
2) Proper cleaning materials are used to clean the flange face and bolting materials.
3) Ensure that precautions are taken to prevent sealing surfaces from being damaged.

Trouble Shooting

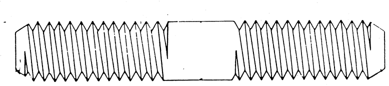
If a gasket assembly leaks, certain attributes can be inspected in the removed gasket that may help identify the cause of failure. The following examinations should be performed.

1) Examine the gasket to determine if it was damaged during installation (e.g., a roll over at the edge of the seating surface).
2) Check for chemical attack and over/under compression.
3) Check for application of an anti-stick or anti-seize compound. These materials can lower the performance of the gasket.
4) Examine the gasket seating surfaces for indications of proper compression and flange face finish.
5) Measure the thickness of the gasket material around the circumference of the seating surface. Compression of the gasket more towards the OD of the seating area than the ID is an indication that flange rotation has occurred due to over torquing or excessive mechanical loads.
6) Leaking flanges may be tightened an additional 10% above the recommended values in Table 4 provided that the torque does not exceed the maximum allowable value listed in Table 5.

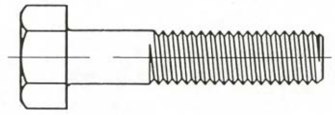
Threaded Fasteners

Threaded fasteners used in flange joints are typically of three different structural shapes; double ended studs, heavy hex bolts, and heavy hex screws.

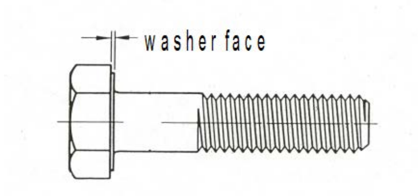
Studs used in flanges are made from rod and typically are threaded on both ends. The shape of the most common type used in flanges, the double-ended stud, is shown in the following sketch. This type of stud has an unthreaded portion in the middle with ends that are either rounded or flat and chamfered.



Heavy hex bolts are externally threaded fasteners designed for insertion through holes in assembled parts, and are normally tightened or released by torquing a nut.



Heavy hex screws are externally threaded fasteners designed for insertion into holes in assembled parts or mating with preformed internal threads and are normally tightened by torquing the head. The primary difference between a hex bolt and a hex screw is the washer face shown in the following sketch.



Heavy hex screws and heavy hex bolts that comply with ASME B18.2.1 are interchangeable regardless of the material specification (e.g., ASTM A307). In some sizes, fastener manufacturers opt to produce only heavy hex screws in lieu of heavy hex bolts due to the interchangeability and greater range of application.

When zinc coating is required, all components of mating fasteners (e.g., bolts, nuts, and washers) shall be coated by the same zinc-coating process.

APPENDIX F – ALIGNMENT FIT-UP TOLERANCES

This Appendix provides guidance on ASME B31.3 Code paragraph 335.1.1 "Alignment." Specifically two sections of the Code are addressed 335.1.1(a) Piping Distortions and 335.1.1(c) Flanged Joints. The data in this Appendix is applicable to either initial installation of the piping system or when performing routine maintenance activities.

PIPING DISTORTIONS

The Code defines piping distortions as any distortion of piping to bring it into alignment for joint assembly that introduces a detrimental strain in equipment or piping components. The Code does not provide criteria on how to evaluate detrimental strain. A limited degree of strain is acceptable for overcoming misalignment at the final closure points in the erection of piping. The amount of misalignment a pipe joint can tolerate is based upon the degree of inherent flexibility available in that system. The degree of acceptable misalignment may be considered as an alignment tolerance.

The methodology applied in Tables 1 and 2 is limited to, three directions of misalignment or displacement misfit at a closure point. The three directions of misalignments are the two axial or lateral directions and face-to-face misalignment. Axial or lateral misalignment is the degree of centerline offset between adjoining sections. Face-to-face misalignment is the amount of separation between adjoining sections that are parallel. In all cases, the two weld-ends at the closure must be parallel within weld fit-up tolerance after cold-pulling. Where this does not occur, one or both weld-ends must be re-beveled for an acceptable fit-up.

The data provided in Table 1 and 2 below should be used as acceptable tolerances on closure fit-up in Code piping systems. Pipe closures made by butt welds, socket welds, and flanged are acceptable when applying the data in Tables 1 and 2.

Table 1 applies only to "strain sensitive" piping systems; those piping systems connected to rotating machinery such as pumps, small turbines, compressors, and unanalyzed vessel and tank nozzles.

Table 2 applies to the non-strain sensitive closures in piping systems.

The lengths of piping tabulated are the minimum total lengths of pipe required which must lie in a direction perpendicular to the direction of a single degree of misalignment to safely permit cold pulling the pipe to close. The example below demonstrates the use of the tables.

Where more than one final closure point occurs in the same system (e.g. between equipment nozzles or full anchor or any combination of these) the misfits at a single point cannot be evaluated independently. No attempt should be made to evaluate and close such a misfit until fit-up conditions are determined in the balance of the system.

When the field misalignments exceed of the values provided in Tables 1 and 2, the piping shall be reworked or evaluated by engineering.

Notes For Tables 1 and 2:

1) The length of piping available for the evaluation of a misfit variation in a particular direction is the sum of the piping leg lengths perpendicular to the direction of the misfit variation, only.

2) Values of the variations and the required pipe lengths for the variations may be interpolated in the table.

3) The tables provide the minimum piping length in units of feet required to accommodate a misfit error in any direction.

TABLE 1 - Pipe Fit-Up Allowances Tolerance For Strain Sensitive Piping

NPS	Misfit Variation In Any Directions (inches)														
(inches)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.40	1.60	1.80	2.00
½	5.5	7.8	9.5	11.0	12.3	13.5	14.5	15.6	16.5	17.4	19.0	20.6	22.0	23.3	24.6
¾	6.1	8.7	10.6	12.3	13.7	15.1	16.3	17.4	18.4	19.4	21.3	23.0	24.6	26.1	27.5
1	6.9	9.7	11.9	13.8	15.4	16.9	18.2	19.5	20.6	21.8	23.8	25.7	27.5	29.2	30.8
1 ½	8.3	11.7	14.3	16.5	18.5	20.3	21.9	23.4	24.8	26.2	28.6	30.9	33.1	35.1	37.0
2	9.2	10.1	16.0	18.5	20.7	22.6	24.5	26.2	27.7	29.2	32.0	34.6	37.0	39.2	41.4
2 ½	10.2	14.4	17.6	20.3	22.7	24.9	26.9	28.8	30.5	32.2	35.2	38.1	40.7	43.2	45.5
3	11.2	15.9	19.4	23.4	25.1	27.5	29.7	31.7	33.7	35.5	38.9	42.0	44.9	47.6	50.2
4	12.7	18.0	22.0	25.5	28.5	31.2	33.7	36.0	38.2	40.2	44.1	47.6	50.9	54.0	56.9
6	15.4	21.8	26.7	30.9	34.5	37.8	40.9	43.7	46.3	48.8	53.5	57.8	61.8	65.5	69.1
8	17.6	24.9	30.5	35.2	39.6	43.2	46.6	49.8	52.9	55.7	61.0	65.9	70.5	74.8	78.8
10	19.7	27.8	34.1	39.3	44.0	48.2	52.0	55.6	59.0	62.2	68.1	73.6	78.7	83.5	88.0
12	21.4	30.3	37.1	42.8	47.9	52.5	56.7	60.6	64.3	67.7	74.2	80.2	85.7	90.9	95.8
14	22.4	31.7	38.9	44.9	50.2	55.0	59.4	63.5	67.3	71.0	77.8	84.0	89.8	95.2	100
16	24.0	33.9	41.6	48.0	53.7	58.8	63.5	67.9	72.0	75.9	83.1	89.8	96.0	102	107
18	25.5	36.0	44.1	50.9	56.9	62.4	67.3	72.0	76.4	80.5	88.2	95.2	102	108	114
20	26.8	37.9	46.5	53.7	60.0	65.7	71.0	75.9	80.5	84.9	93.0	100	107	114	120
22	28.1	39.8	48.7	56.3	62.9	68.9	74.5	79.6	84.4	89.0	97.5	105	113	119	126
24	29.4	41.6	50.9	58.8	65.7	72.0	77.8	83.1	88.2	93.0	102	110	118	125	131
26	30.6	43.3	53.0	61.2	68.4	74.9	80.9	86.5	91.8	96.7	106	114	122	130	137
28	31.7	44.9	55.0	63.5	71.0	77.8	84.0	89.8	95.2	100	110	119	127	135	142
30	32.9	46.5	56.9	65.7	73.5	80.5	86.9	93.0	98.6	104	114	123	131	139	147

TABLE 2 - Pipe Fit-Up Tolerances For Non Strain Sensitive Piping

NPS	Misfit Variation In Any Directions (inches)														
(inches)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.40	1.60	1.80	2.00
½	3.9	5.5	6.7	7.8	8.7	9.5	10.3	11.0	11.7	12.3	13.5	14.5	15.6	16.5	17.4
¾	4.3	6.1	7.5	8.7	9.7	10.6	11.5	12.3	13.0	13.7	15.1	16.3	17.4	18.4	19.4
1	4.9	6.9	8.4	9.7	10.9	11.9	12.9	13.8	14.6	15.4	16.9	18.2	19.5	20.6	21.8
1 ½	5.8	8.0	10.1	11.7	13.1	14.0	15.5	16.5	17.5	18.5	20.0	21.9	23.4	24.8	26.0
2	6.5	9.2	11.0	13.1	14.6	16.0	17.3	18.5	19.6	20.7	22.6	24.5	26.2	27.7	29.2
2 ½	7.2	10.2	12.5	14.4	16.1	17.6	19.0	20.3	21.6	22.7	24.9	26.9	28.8	30.5	32.2
3	7.9	11.2	13.7	15.9	17.7	19.4	21.0	22.4	23.8	25.1	27.5	29.7	31.7	33.7	35.5
4	9.0	12.7	15.6	18.0	20.1	22.0	23.8	25.5	27.0	28.5	31.2	33.7	36.0	38.2	40.2
6	10.9	15.4	18.9	21.8	24.4	26.7	28.9	30.9	32.8	34.5	37.0	40.9	43.7	46.0	48.8
8	12.5	17.6	21.6	24.9	27.9	30.5	33.0	35.2	37.4	39.4	43.2	46.6	49.8	52.9	55.7
10	13.9	19.7	24.1	27.9	31.1	34.1	36.8	39.1	41.7	44.0	48.2	52.0	55.6	59.0	62.2
12	15.1	21.4	26.2	30.3	33.9	37.1	40.1	42.8	45.4	47.9	52.5	56.7	60.6	64.0	67.7
14	15.9	22.6	27.5	31.7	35.5	38.9	42.0	44.9	47.6	50.2	55.0	59.4	63.5	67.0	71.0
16	17.0	24.0	29.4	33.9	37.9	41.6	44.9	48.0	50.9	53.7	58.8	63.5	67.9	72.0	75.9
18	18.0	25.5	31.2	36.0	40.2	44.1	47.6	50.9	54.0	56.9	62.4	67.3	72.0	76.4	80.5
20	19.0	26.8	32.9	37.9	42.4	46.5	50.2	53.7	56.9	60.0	65.7	71.0	75.9	80.5	84.9
22	19.9	28.1	34.5	39.8	44.5	48.7	52.6	56.3	59.7	62.9	68.9	76.5	79.6	84.4	89.0
24	20.8	29.4	36.0	41.6	46.4	50.9	55.0	58.8	62.4	65.7	72.0	77.8	83.1	88.2	93.0
26	21.6	30.6	37.5	43.3	48.4	53.0	57.2	61.2	64.9	68.4	74.9	80.9	86.5	91.8	96.7
28	22.4	31.7	38.9	44.9	50.2	55.0	59.6	61.5	67.3	71.0	77.8	84.0	89.8	95.2	100
30	23.2	32.9	40.2	46.5	52.0	56.9	61.5	65.7	69.7	73.5	80.5	86.9	93.0	98.6	104

EXAMPLE:

Figure 1 illustrates a simple two-ended piping system with three directions of misfit at the final closure point. Each direction of misfit must be evaluated separately as follows.

For the ∆X misfit of 0.50”

The total length of piping perpendicular to ∆X (six legs) equals 74 feet; the minimum length required for a 0.50” misfit in 10” piping in Table 1 is 44.0 feet. Since the available piping exceeds this, the misfit is acceptable.

For the ∆Y misfit of 0.75”

The total length of piping perpendicular to ∆Y (six legs) equals 119 feet; the minimum length required for a 0.75” misfit in 10” piping in Table 1 is 53.8 feet. Since the available piping exceeds this, this misfit is also acceptable.

For the ∆Z misfit of 0.40”

The total length of piping perpendicular to ∆Z (four legs) equals 77 feet; the minimum length required for 0.40” misfit in Table 1 is 39.3 feet. Since the available piping exceeds this, the ∆Z misfit is acceptable, as well.

In this example, since all directions of misfit are within the allowance limitations, the piping may be cold-pulled to fit-up alignment.

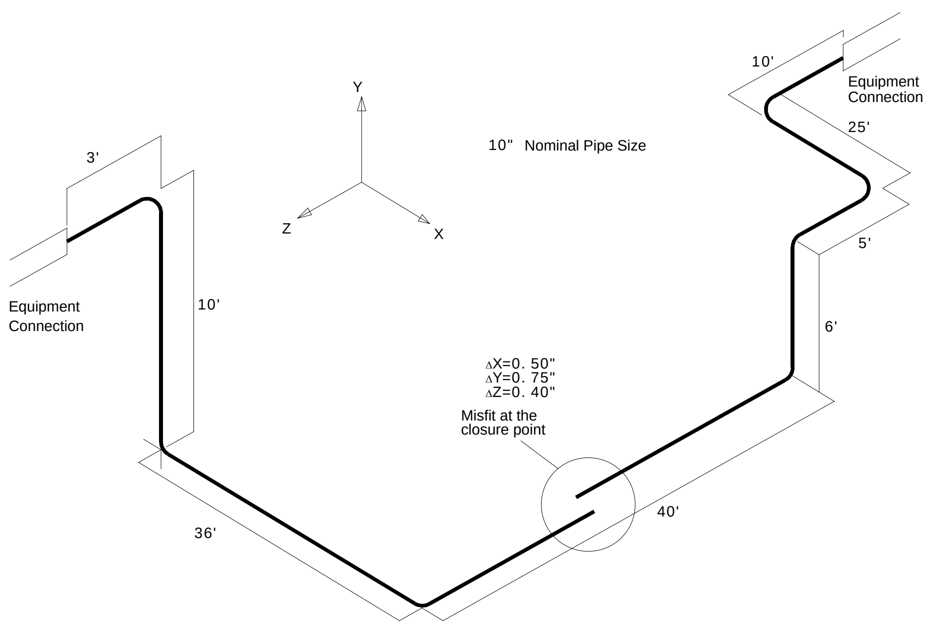


FIGURE 1

FLANGED JOINTS

The ASME B31.3 Code provides a rotational misalignment criterion for flanged Joints. Rotational misalignment is the amount the flanges are out-of-parallel. The Code criterion requires that prior to bolting, flange faces shall be aligned to the design plane within 1/16 in./ft measured across any diameter. During field assembly these tolerances may be difficult to achieve, especially for small flanges. Allowable flange rotational misalignments above those in the Code are provided in Table 3 for flange assemble with the limitations provided below. Table 3 provides an allowable gap based on the distance between two closest supports as shown in Figure 2.

The gap values provided in Table 3 apply to flanges fabricated to the following listed standards: ASME B16.5, AWWA C207, and MSS SP-44.

The flanges shall be assembled using the flange assembly procedure in Appendix E of this procedure.

The allowable gap values provided are to be compared to measurements taken prior to applying any preload (torque) to the flange bolts.

When these allowable gap values are applied, the required bolt torque to assemble the flange should be those provided in Appendix E with a 20% increase.

When these allowable gap values are applied during assembly, it is required to recheck the gap between the flange faces after 1/3 of the total required torque is applied to the bolts. After 1/3 of the torque is applied to the bolts, the maximum difference in gap must be within the ASME B31.3 requirements (flange faces must be parallel to within 1/16 in/ft measured across any diameter). If the gap is not within the B31.3 requirement after 1/3 of the total torque is applied rework or an engineering evaluation is required.

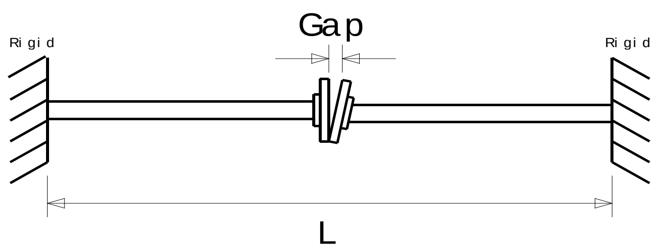


FIGURE 2

Table 3 -- Allowable Flange Gap (in.)

	Pipe Sizes - NPS										
Minimum Length "L" Between Supports (in.)	½	¾	**1**	**1 ½**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
10	0.092	0.082	0.071	0.058	0.056	0.047	0.044	0.037	0.035	0.033	0.033
14	0.129	0.114	0.100	0.081	0.078	0.066	0.062	0.051	0.048	0.046	0.046
18	0.166	0.147	0.129	0.105	0.100	0.085	0.080	0.066	0.062	0.059	0.059
22	0.203	0.180	0.157	0.128	0.123	0.104	0.097	0.081	0.076	0.072	0.072
26	0.240	0.212	0.186	0.151	0.145	0.123	0.115	0.095	0.090	0.086	0.086
30	0.277	0.245	0.214	0.174	0.167	0.142	0.133	0.110	0.104	0.099	0.099
34	0.314	0.278	0.243	0.198	0.190	0.161	0.150	0.125	0.118	0.112	0.112
38	0.351	0.311	0.272	0.221	0.212	0.180	0.168	0.139	0.134	0.125	0.125
42	0.389	0.344	0.300	0.244	0.235	0.199	0.186	0.154	0.145	0.138	0.138
46	0.425	0.377	0.329	0.268	0.257	0.218	0.203	0.169	0.159	0.151	0.151
50	0.463	0.410	0.358	0.291	0.279	0.237	0.221	0.183	0.173	0.164	0.165
54	0.500	0.443	0.387	0.134	0.302	0.256	0.234	0.198	0.188	0.178	0.178
58	0.538	0.476	0.415	0.338	0.324	0.275	0.256	0.213	0.201	0.191	0.191
62	0.576	0.509	0.444	0.361	0.346	0.294	0.274	0.227	0.214	0.204	0.204
66	0.614	0.542	0.473	0.384	0.369	0.313	0.292	0.242	0.228	0.217	0.217
70	0.652	0.575	0.502	0.408	0.391	0.332	0.309	0.257	0.242	0.230	0.230
74	0.690	0.609	0.531	0.431	0.414	0.351	0.327	0.271	0.256	0.243	0.244
78	0.728	0.642	0.560	0.455	0.436	0.369	0.345	0.286	0.270	0.256	0.257
82	0.767	0.676	0.589	0.478	0.458	0.388	0.362	0.301	0.284	0.270	0.267
86	0.805	0.710	0.618	0.502	0.481	0.407	0.380	0.315	0.297	0.283	0.283
90	0.844	0.743	0.647	0.525	0.503	0.426	0.398	0.330	0.311	0.296	0.296
94	0.883	0.777	0.677	0.549	0.526	0.445	0.416	0.345	0.325	0.309	0.309
98	0.922	0.811	0.706	0.572	0.548	0.464	0.433	0.356	0.339	0.322	0.323
102	0.962	0.845	0.735	0.596	0.571	0.483	0.451	0.374	0.353	0.335	0.336
106	1.002	0.880	0.765	0.619	0.593	0.502	0.469	0.389	0.367	0.349	0.349
110	1.041	0.914	0.794	0.643	0.616	0.521	0.486	0.404	0.380	0.362	0.362

APPENDIX G – COMPONENT IDENTIFICATION

The ASME B31.3 Code requires random examination of materials and components to ensure conformance to listed specifications and standards. B31.3 also requires these materials to be free from defects. Component standards and specifications have various marking requirements. The intent of this appendix is to provide a convenient easy-to-use summary of the marking requirements for several commonly used piping components.

TABLE 1 - Generic Marking Standards and Requirements

Standard	Title and Requirements
MSS SP-25	***Standard Marking System for Valves, Fittings, Flanges and Unions*** 1. Manufacturer's Name or Trademark 2. Rating Designation 3. Material Designation 4. Melt Designation - as required by specification 5. Valve Trim Identification - valves only when required 6. Size Designation 7. Identification of Threaded Ends 8. Ring-Joint Facing Identification 9. Permissible Omission of Markings *Specific Marking Requirements* Marking Requirements for Flanges, Flanged Fittings, and Flanged Unions Marking Requirements for Threaded Fittings and Union Nuts Marking Requirements for Welding and Solder Joint Fittings and Unions Marking Requirements for Non-Ferrous Valves Marking Requirements for Cast Iron Valves Marking Requirements for Ductile Iron Valves Marking Requirements for Steel Valves

MSS SP-25 is the most commonly used marking standard. It contains a variety of specific marking requirements that are too lengthy to list in this appendix; please refer to it when necessary to confirm the markings on a component.

The remainder of this appendix contains marking requirements divided into the following tables:

Table	Has marking requirements for
2	Piping and Tubing
3	Flanges and Flanged Fittings
4	Fittings (includes welded and threaded fittings)
5	Valves
6	Fasteners

TABLE 2 -- Pipe and Tube

Standard	Title and Marking Requirements
ASTM A53	***Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless*** 1. Name of Brand of Manufacturer 2. Kind of Pipe (e.g. ERW B, XS) 3. Specification Number 4. Length
ASTM A106	***Seamless Carbon Steel Pipe for High-Temperature Service*** 1. Marking requirements of A530/A530M 2. Heat Number 3. Hydro/NDE Marking 4. "S" for supplementary requirements as specified (stress-relieved annealed tubes, air underwater pressure test, and stabilizing heat treatment) 5. Length 6. Schedule Number 7. Weight on NPS 4 and larger
ASTM A269	***Seamless and Welded Austenitic Stainless Steel Tubing for General Service*** 1. Marking requirements of A450/A450M 2. Seamless or Welded
ASTM A312	***Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*** 1. Marking requirements of A530/A530M 2. Manufacturer's Private Identifying Mark 3. Seamless or Welded
ASTM A530/A530A	***Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe*** 1. Manufacturer's Name 2. Specification Grade
ASTM A450/A450M	***Standard Specification for General Requirements for Carbon –and Low Alloy Steel Tube*** 1. Manufacturer's Name 2. Specification Grade
ASTM B88	***Specification for Seamless Copper Water Tube*** 1. Name of Trademark of Manufacturer (interval $\leq$ 1½ ft) 2. Type (i.e. K, L, or M) (interval $\leq$ 1½ ft) ***Straight Lengths*** 1. Type of the tube, name or trademark of the manufacturer, or both, and the country of origin repeated at intervals not greater than 3 ft. 2. Continuous colored stripe, symbol or logo not less than 3/16" high.
AWWA C115/A21.15	***Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges*** 1. Length and weight shown of each pipe. 2.Manufacturer's Mark 3. Country where cast. 4.DI if ductile iron and GI if gray iron.

Standard	Title and Marking Requirements
AWWA C900	***Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in., for Water Distribution*** Markings on pipe shall include the following at not more than 5 ft. intervals. 1. Nominal size and OD base (e.g. 4 CI) 2. PVC 3. Dimension ratio (e.g. DR 25) 4. AWWA pressure class (e.g. PC 100) 5. Manufacturer's name or trademark 6. AWWA designations (AWWA C900) 7. Seal of testing agency is optional Couplings contain the same markings except the AWWA pressure class is not required.
AWWA C905	***Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in.. Through 48 In., for Water Transmission and Distribution.*** Markings on pipe shall include the following at not more than 5 ft. intervals. 1.Nominal size and OD base (e.g. 24 CI) 2.PVC 3.Dimension ratio (e.g. DR 25) 4.AWWA pressure class (e.g. PC 160) 5.Manufacturer's name or trademark 6.AWWA designations (AWWA C905) 7.Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacturer.

TABLE 3 -- Flanges and Flanged Fittings

Standard	Title and Marking Requirements
ASME B16.1	***Gray Iron Pipe Flanges and Flanged Fittings Classes 25,125, and 250*** 1. Manufacturer's Name or Trademark and Numeral as shown below: Rating Class / Size / Numeral 25 / All / 25 125 / 1 to 12 / 125 14 to 24 / 100 30 to 48 / 50 250 / 1 to 12 / 250 14 to 24 / 200 30 to 48 / 100 800 / 2 to 12 / 800
ASME B16.5	***Pipe Flanges and Flanged Fittings*** 1. Manufacturer's Name or Trademark 2. ASTM Specification and Grade 3. Rating Class 4. "B16" 5. Size
ASME B16.24	***Cast Copper Alloy Pipe Flanges and Flanges Fittings, Class 150, 300, 600, 900, 1500 and 2500*** Except as noted below, flanges and flanged fittings shall be marked as required in MSS SP-25. 1. Manufacturer's Name or Trademark 2. ASTM Specification and Grade 3. Rating Class 4. "B16" 5. Size
ASME B16.36	***Orifice Flanges*** 1. Flanges shall be marked as required by ASME B16.5 2. For welding neck flanges only, the bore diameter shall be marked.
ASME B16.42	***Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300*** Except as noted below, flanges and flanged fittings shall be marked as required in MSS SP-25. 1. Manufacturer's Name or Trademark 2. Material - "DUCTILE" or D.I. if space does not permit 3. Rating Class 4. "B16" 5. Size
MSS SP-44	***Steel Pipeline Flanges*** 1. Marked in accordance with MSS SP-25. 2. "PL" precedes the grade symbol marking.
MSS SP-51	***Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings*** 1. Manufacturer's name or trademark. 2. Class designation. 3. Material designation. 4. Melt identification. 5. Size.

TABLE 4 -- Fittings

Standard	Title and Marking Requirements
AWWA C110/A21.10	***Ductile-Iron and Gray-Iron Fittings*** 1. Pressure rating. 2. Nominal diameter. 3. Manufacturer's identification. 4. Country where cast. 5. Degrees or fractions for all bends. 6. "DI" or "Ductile" for ductile iron.
AWWA C111/A21.11	***Rubber-Gasket Joints For Ductile-Iron Pressure Pipe and Fittings*** 1. Pipe and fittings having push-on joints shall be marked with the proprietary name or trademark of the joint. 2. Bolts and nuts shall have a mark to identify the material and producer.
AWWA C153/A21.53	***Ductile Iron Compact Fittings*** 1. C153 2. Pressure rating. 3. Nominal diameter. 4. Manufacturer's identification. 5. Country where cast. 6. "DI" or "Ductile" for ductile iron. 7. Degrees or fractions for all bends.
AWWA C907	**Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. for Water, Wastewater, and Reclaimed Water Service** 1. Nominal size 2. Code identifying the production run. 3. PVC 4. AWWA identification number for this standard (AWWA C907) 5. Pressure Class (cL150). 6. Manufacturer's name or trademark. 7. Numbers of degrees, or fraction of a circle, on all bends.
ASME B16.3	***Malleable Iron Threaded Fittings, Classes 150 and 300*** 1. Class 150 - Manufacturer's Name or Trademark 2. Class 300 - Manufacturer's Name or Trademark - Numerals "300" - Letters "MI" for malleable iron - Size - Other marking as permitted by MSS SP-25
ASME B16.4	***Gray Iron Threaded Fittings, Classes 125 and 250*** 1. Class 125 - Manufacturer's Name or Trademark 2. Class 250 - Manufacturer's Name or Trademark - Numerals "250"
ASME B16.9	***Factory-Made Wrought Buttwelding Fittings*** 1. Manufacturer's Name or Trademark 2. Material and Product Identification (ASTM or ASME grade symbol). 3. "WP" in grade symbol. 4. Schedule number or nominal wall thickness. 5. NPS

Standard	Title and Marking Requirements
ASME B16.11	***Forged Fittings, Socket-Welding and Threaded*** 1. Manufacturer's Name or Trademark. 2. Material identification in accordance with the appropriate ASTM. 3. Product conformance symbol, either "WP" or "B16". 4. Class designation - 2000, 3000, 6000, or 9000. Where size and shape do not permit all of the above markings, they may be omitted in the reverse order given above.
ASME B16.14	***Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads*** 1. Manufacturer's Name or Trademark except where impractical
ASME B16.18	***Cast Copper Alloy Solder Joint Pressure Fittings*** 1. Manufacturer's Name or Trademark in accordance with MSS SP-25. Markings of fittings less than ½ " is optional and may be omitted if not practical.
ASME B16.22	***Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*** 1. Manufacturer's Name or Trademark in accordance with MSS SP-25 2.Markings may be omitted from any fitting where it may damage soldering surfaces.
ASME B16.28	***Wrought Steel Buttwelding Short Radius Elbows and Returns*** 1. Manufacturer's Name or Trademark 2. Material (ASTM Specification and Grade); prefix "WP" must appear in the grade symbol 3. Schedule number or nominal wall thickness 4. Size
ASME B16.39	***Malleable Iron Threaded Pipe Unions*** 1.Unions shall be marked on the nut with the manufacturer's name or trademark and nominal pressure class except on bar stock unions where marking is impractical. 2. Additional markings as permitted by MSS SP-25 may be used.
MSS SP-43	***Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications*** 1.Manufacturer's Name or Trademark 2."CR" followed by ASTM or AISI material identification symbol 3.Schedule number or nominal wall thickness designation 4.Size
MSS SP-79	***Socket-Welding Reducer Inserts*** 1.Markings in accordance with MSS SP-25. Markings are to be located close to the reduced opening so they will be visible after welding. 2.Markings shall include (but not limited to) the following: - Manufacturer's Name of Trademark - Material Identification - Class Designation (3000 or 6000) - Size
MSS SP-83	***Steel Pipe Unions, Socket-Welding and Threaded*** 1.Markings in accordance with MSS SP-25 2.Markings shall include (but not limited to) the following: - Manufacturer's Name of Trademark - Material Identification (ASTM A105/A182) - Class 3000 - Size

TABLE 5 -- Valves

Standard	Title and Marking Requirements
API Standard 602	***Compact Steel Gate Valves - Flanged, Threaded, Welded, and Extended Body Ends*** 1. Valves shall be marked in accordance with the requirements of ASME B16.34. 2. Each valve shall have a corrosion-resistant metal identification plate with the following information: - Manufacturer - Manufacturer's model, type, or figure number - Size - Applicable pressure rating at 100°F - Body material - Trim material 3. Valve bodies shall be marked as follows: - Threaded-end or socket-welding-end valves - 800 or 1500 - Flanged-end valves - 150, 300, 600, or 1500 - Buttwelding-end valves - 150, 300, 600, 800, or 1500
ASME B16.34	***Valves - Flanged, Threaded and Welding End*** 1. Manufacturer's Name or Trademark 2. Valve Body Material *Cast Valves* - Heat Number and Material Grade *Forged or Fabricated Valves* - ASTM Specification and Grade 3. Rating 4. Size 5. Where size and shape do not permit all of the above markings, they may be omitted in the reverse order given above. 6. For all valves, the identification plate shall show the applicable pressure rating at 100°F and other markings required by MSS SP-25.
MSS SP-71	***Gray Iron Swing Check Valves, Flanged and Threaded Ends*** 1.Markings shall conform to MSS SP-25
MSS SP-72	***Ball Valves with Flanged or Butt-welding Ends for General Service*** 1.Marker in accordance with MSS SP-25.
MSS SP-78	***Gray Iron Plug Valves, Flanged and Threaded Ends*** 1.Markings conform to MSS SP-25.
MSS SP-80	***Bronze Gate, Globe, Angle and Check Valves*** 1.Markings shall conform to MSS SP-25. 2.All bronze check valve bodies shall be marked to indicate the direction of flow by means of an arrow cast on the valve body or by the word "in" or "inlet" cast or stamped on the inlet end of the body.
MSS SP-85	***Gray Iron Globe and Angle Valves, Flanged and Threaded Ends*** 1. Markings shall conform to MSS SP-25

TABLE 6 -- Fasteners

Standard	Title and Marking Requirements
ASTM 193	***Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High Pressure Service and Other Special Purpose Applications*** 1. Grade or manufacturer's identification symbols shall be applied to one end of studs 3/8" in diameter and larger ands to the heads of bolts ¼ " in diameter and larger.
ASTM 194	***Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service*, or Both** 1. Manufacturer's identification mark. 2. Grade and process of manufacture (e.g. 8F indicates nuts that are hot-forged or cold-forged)
ASTM 307	***Specification for Carbon Steel Bolts, Studs*, and Threaded Rod 60 000 PSI Tensile Strength** 1. Manufacturer's identification mark. 2. All bolt heads, one end of studs 3/8" and larger, and whenever feasible studs less than 3/8", shall be marked with a grade material.
ASTM 563	***Specification for Carbon and Alloy Steel Nuts*** 1. Grades O, A, and B are not required to be marked unless identified as such by the purchaser. 2. Grade D, DH, DH3 shall be marked with the symbol HX3 on one face. Heavy hex nuts made to the requirements of DH3 are marked with HX3 on one face. 3. Grades C, C3, D, DH, and DH3 and hex nuts made to the requirements of DH3, are marked with the manufacturers symbol.

APPENDIX H – LEAK/PRESSURE TESTING

PURPOSE

This Appendix provides guidance for hydrostatic and pneumatic tests. The specific code requirements are contained in paragraph 345 of ASME B31.3.

SCOPE

The information in this Appendix applies to the testing of metallic Category D and Normal fluid service process piping systems constructed to ASME B31.3 "Process Piping". Nonmetallic piping and other fluid service categories have additional requirements.

GENERAL

TEST PREPARATION

1) All Code and design required examinations shall be complete prior to testing

373 A preliminary walk-down of the piping to be tested shall be made. Test personnel shall correct and/or identify test boundaries, any problems, incomplete items, joint access, fill points, vent points and any scaffolding required.

374 All joints, including welds and mechanical joints are to be left un-insulated and exposed for examination during the test, except that joints previously tested may be insulated or covered.

375 Hangers and supports shall be placed in the proper position prior to the filling of the system to be tested.

376 Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary to support the weight of the test liquid, as designated by the designer. Spring hangers should be placed in the locked position.

377 Expansion joints shall be provided with temporary restraint if required for additional pressure load under test, or shall be isolated from the test.

378 The test personnel shall assure that the components (e.g. instruments, valves, etc.) that are not to be subjected to the pressure test, are either disconnected from the piping or isolated by blind flanges or other means during the tests. Valves may be used for isolation, provided the valve (including the closure mechanism) is suitable for the proposed test pressure.

379 A flanged joint at which a blank is inserted to isolate other equipment during the test need not be examined for leaks. These joints should be leak tested during initial service.

380 If a pressure test is to be maintained for a period of time and the test liquid in the system is subject to changes in temperature, precautions shall be taken to avoid excessive pressure due to thermal expansion or freezing.

381 A preliminary air test at not more than 25 psi gage pressure may be made prior to hydrostatic test in order to locate major leaks.

382 A test record shall be made for each leak test. The record shall include the following:

383 Date of test

384 Identification of piping to be tested (test boundaries)

385 Test fluid

386 Test pressure

387 Certification of the examiner

388 An example Pressure Test Record is provided at the end of this appendix.

389 Following hydrostatic or pneumatic leak testing, the piping system should be cleaned, and dried if necessary. Refer to Appendix K for cleaning techniques.

390 Prior to in-service leak test, the piping system should be cleaned, and dried if necessary. Refer to Appendix K for cleaning techniques.

391 During Hydrostatic testing or in-service leak testing, strainers should be used to protect equipment against the introduction of construction debris or dirt.

HYDROSTATIC LEAK TEST

TEST FLUID

1) The test fluid shall be water unless there is a possibility of damage due to freezing, or if the process or piping material would be adversely affected by water. In that case other suitable test fluids may be used. Special precautions are required if the test fluid is toxic or flammable.

392 The temperature of the test fluid should be no less than 40°F in piping systems subject to brittle fracture (i.e. carbon steel).

393 If the test fluid temperature produces condensation on the piping exterior surface, the water shall be heated to a temperature above the dew point or the test shall be postponed to a time when the dew point temperature has changed sufficiently such that condensation will not occur on the piping exterior surface.

394 Material and test water temperature shall be approximately equal prior to pressurizing the system.

395 High points in the system shall be vented so that air will be displaced while the system is being filled with the test fluid.

396 The operator shall take adequate measures to ensure that the piping system is not over-pressurized during hydrostatic testing. Adequate measures include a relief valve, or a dedicated operator to monitor pressure, or dual pressure regulators, etc.

TEST PRESSURE

1) The minimum hydrostatic test pressure for metallic piping shall be per the following equation.

$$P_T = 1.5 \times P_D \times S_T/S_D$$

where: P_T = minimum test gage pressure
P_D = internal design gage pressure
S_T = allowable stress value at test temperature
S_D = allowable stress value at design temperature

Note: The maximum allowable value of S_T/S_D is 6.5

397 When a maximum test pressure is specified, the test pressure shall not exceed this amount.

398 When no maximum test pressure is specified, the test shall not be greater than 110% of the minimum.

399 When using water, static head due to differences in the elevation of the top of the piping system and the elevation of the test gage shall be accounted for in pressuring the piping system to be tested by the following equations:

SH (psi) = (HE - GE) x 0.433

$P_{ST} = P_T + SH$

where: HE = high point elevation (ft)

GE = gage point elevation (ft)

SH = static head (psi)

P_{ST} = minimum test gage pressure corrected for static head

0.433 = conversion factor (ft of waster to psi)

400 Pressure gages should be connected directly to the piping. Calibrated pressure gages shall be used in all Code testing. Pressure gage range should exceed the intended test pressure by approximately double but in no case should the range be less than one and one-half (1 ½) times the test pressure.

HYDROSTATIC TESTING OF PIPING WITH VESSELS AS A SYSTEM

1) Where the test pressure of piping attached to a vessel is the same as or less than the test pressure for the vessel, the piping may be tested with the vessel at the test pressure of the piping.

401 Where the test pressure of the piping exceeds the vessel test pressure and isolation is not considered practicable, the piping and the vessel may be tested together at the test pressure of the vessel, if approved by the design authority. The vessel test pressure must not be less then 77% of the piping test pressure.

EXAMINATION FOR LEAKS

1) Test personnel shall ensure the hydrostatic pressure is maintained for sufficient time to determine if there are any leaks. A minimum time of 10 minutes is required by Code. After the hydrostatic pressure time has been satisfied, all joints shall examined visually for leaks.

402 Examination shall be made of all welds and mechanical joints. There shall be no visible evidence of leakage. Welds and joints previously tested need not be examined for leaks.

403 Leakage detected in welded joints shall be repaired by draining, repair welding, non-destructively examining in accordance with original requirements, and re-tested to the original test pressure.

404 Mechanical joint leakage at permanent joints shall be repaired, examined in accordance with original requirements, and re-tested to the original test pressure.

PNEUMATIC TESTING

PRECAUTIONS

Pneumatic testing involves a hazard due to possible release of energy stored in compressed gas. Care must be taken to minimize the chance of brittle failure during testing by initially assuring the system is suitable for pneumatic testing. Pneumatic testing may be used in lieu of hydrostatic testing, recognizing the hazard of energy stored in compressed gas, when a hydrostatic test is considered impracticable. Guidance for when to use a pneumatic test is provided below.

1) When components, appurtenances, or systems are so designed or supported that they cannot be safely filled with water.

405 When components, appurtenances, or systems, that are not readily dried, are to be used in services where traces of the testing medium cannot be tolerated.

TEST FLUID

Air or Nitrogen shall be used as a test medium unless otherwise specified by engineering. Special precautions are required if the test fluid is toxic or flammable.

TEST PRESSURE

1) The pneumatic test pressure shall be per the following equation.

$P_T = 1.1 \text{ X } P_D$

where:
P_T = test gage pressure
P_D = internal design gage pressure

406 Temporary test pressure relief device shall be provided during pneumatic testing. The set pressure shall not be higher than the test pressure plus the lesser of 50 psi or 10% of the test pressure.

EXAMINATION FOR LEAKS

1) The pressure in the piping system shall be increased gradually in steps providing sufficient time to allow the piping to equalize strains during the test. When the system pressure reaches the lesser of ½ the test pressure or 25 psi a preliminary leak check of the system shall be made. Following the preliminary leak check the pressure shall be increased gradually until the test pressure is reached. The pressure shall then be reduced to the design pressure before examining for leaks.

407 Examination shall be made of all welds and mechanical joints. There shall be no visible evidence of leakage. Welds and joints previously tested need not be examined for leaks.

408 During pneumatic tests, all joints shall be examined with a bubble-producing solution specifically compounded for leak detection.

409 Leakage detected in welded joints shall be repaired by de-pressurizing, repair welding, non-destructively examined as the original, and re-tested to the original test pressure.

410 Mechanical joint leakage at permanent joints shall be repaired, examined as original, and re-tested to the original test pressure.

PIPING SUBJECT TO EXTERNAL PRESSURE

TEST METHOD

Either the hydrostatic or pneumatic test method described above may be used to test externally pressured piping. The piping shall be tested at an internal gage pressure 1.5 times the external pressure, but not less then 15 psi.

PRESSURE TEST RECORD

[SAMPLE – Edit to suit but capture all data required for ASME B31 compliance]

TEST NUMBER:	PROJECT NO.:	PAGE 1 OF	
PROJECT NAME:			
TEST INFORMATION			
SYSTEM DESCRIPTION:			
DESCRIPTION OF TEST BOUNDARIES: (Attach Sketch Showing Boundaries as Required. P&ID Recommended)			
DESIGN TEMPERATURE:	DESIGN PRESSURE:		
TEST METHOD: ☐ HYDROSTATIC ☐ PNEUMATIC:			
TEST FLUID:	APPLICABLE CODE:		
TEST REQUIREMENTS			
REQUIRED TEST PRESSURE:	TEST FLUID TEMPERATURE:		
REQUIRED TEST DURATION:	AMBIENT TEMPERATURE:		
GAUGE PRESSURE CALCULATION (See Section 4.2.4)			
ELEVATION DIFFERENCE BETWEEN GAUGE AND HIGH POINT:			
X CONVERSION FACTOR:			
PLUS REQUIRED TEST PRESSURE:			
EQUALS REQUIRED GAUGE PRESSURE:			
TEST RESULTS			
TEST DATE:	START TIME:	☐ AM ☐ PM	
	FINISH TIME:	☐ AM ☐ PM	
ACTUAL GAUGE PRESSURE:			
TEST EQUIPMENT			
TYPE:	RANGE:	CAL. DATE:	CAL. DUE:
REMARKS:			
TEST ACCEPTANCE			
CODE EXAMINER:	DATE:		
CODE INSPECTOR:	DATE:		

APPENDIX I – STRESS ANALYSIS

This appendix provides a guide for Stress Analysis and Qualification for Compliance with ASME B31.3, paragraphs 302.3.5 Limits of Calculated Stresses Due to Sustained Loads and Displacement Strains, and 302.3.6 Limits of Calculated Stresses due to Occasional Loads of above ground piping.

Scope and Boundaries of Piping Systems

The qualification documentation for piping systems analyzed to the requirements of this procedure should include a system diagram (P&ID sketch) and a stress isometric indicating the scope and boundaries (end points) of the analysis. The isometric should include support location, type and direction, location of components and the coordinate system (For the purpose of uniformity, coordinates North = + X, Up = + Y and East = + Z are recommended).

The piping system analytical model should extend to in-line structural anchors (six-way restraints) or nozzles of anchored equipment. Otherwise, the analytical model should overlap into adjacent piping, beyond the scope of the system to be qualified. The extent of overlap should be sufficient to reflect the loading transmitted from the overlap onto the in-scope piping system.

For the purpose of analysis, branch lines can be decoupled from the header piping provided all of the following conditions are met:

- The ratio of branch to header pipe moment of inertia is such that $I_{branch} < I_{header} / 2S$
- The header pipe movements are properly considered in the analysis of the branch pipe
- When seismic qualification is required, the applied spectra should envelope the header pipe support attachment points

Applied boundary conditions include differential thermal expansion and dynamic anchor movements or gaps at building and equipment attachment points. Differential movements of less than ¼ " may be neglected, except at equipment nozzles.

Pipe Supports and Equipment Analytical Models

The stiffness of pipe supports and equipment should be considered in dynamic analysis. Supports and equipment may be considered to be rigid provided either one of the following conditions are met:

- The support or equipment fundamental frequency is greater than the frequency corresponding to the zero period acceleration
- The support or equipment stiffness exceeds the minimum rigid values of Table I-1

Table I-1
Minimum Rigid Support and Equipment Stiffness

Pipe Size	Translational Stiffness (lb/in)	Rotational Stiffness (in-lb/rad)
≤ ¾ "	1E4	1E6
1" to 2"	1E5	1E7
3" to 4"	5E5	5E7
≥ 6"	1E6	1E8

A rigid support or equipment may be assigned the stiffness values of Table I-1 or a larger stiffness. Otherwise, the actual support stiffness should be accounted for.

To reduce unnecessary iterations, it is important that stiffness values be rounded.

One-way vertical downward supports may be modeled as two-way restraints in dynamic analysis, provided the following four conditions are met:

- The pipe, should it uplift (thermal + seismic up > deadweight down), will not fall off the support.
- The support can withstand a total applied downward load equal to twice the resultant vertical static load plus the calculated vertical dynamic load.
- The pipe span adjacent to the one-way support, on either side, does not contain impact sensitive equipment or components.
- The pipe span adjacent to the one-way support is not attached to an equipment nozzle.

The lateral restoring force of rod hangers may be included in the piping system model, as an equivalent linear lateral stiffness, (k = tributary weight of pipe span/rod length) from pin centerline to pipe center line provided the swing angle can be accommodated by the rod and anchor design.

Modeling Tolerances

Guidance on tolerances is provided in ASME B&PV Section III Appendix T – Recommended Tolerances for Reconciliation of Piping Systems. Layer tolerances may be applied where the applied stress is a small fraction of the allowable stress. Tolerance on segment lengths and fitting locations may be the larger of ±1 foot or ± D/2. Deviations between the analytical model and the as-built condition beyond the above tolerances must be reconciled.

Loading Conditions

The design documents shall specify the applicable loading, based on the applicable standard (such as IBC) or typical requirements. The following load combinations are provided for guidance.

LOAD COMBINATIONS FOR THE QUALIFICATION OF PIPING SYSTEMS

Normal (sustained) $P_o + DW$

Normal (occasional) $P_o + DW + FT_N$ *or* $P_o + DW + W_L$

Thermal Th_N

Faulted $P_o + DW+(FT_{FD}{}^2+DBE^2)^{½}$
$P_o + DW + FT_F$
$P_o + DW + W_L$

Notes:

P_o = Normal system operation pressure

DW = Deadweight

FT_i = Fluid transient loads, under plant condition i (normal sustained, normal occasional or faulted)

Th_i = Thermal expansion or discontinuity stress, under plant condition i (normal sustained, normal occasional or faulted). Faulted thermal loads, Th_F, need not be considered in piping qualification, but should be considered in support qualification. Piping Thermal stresses are qualified separately from other applied loads, as defined in ASME III or B31.1

W_L = Wind loads

FT_{FD} = Faulted fluid transients which result from a DBE

DBE = Design basis earthquake loads equal to the SRSS of inertia and anchor motion loads.

Stress Analysis

DEADWEIGHT ANALYSIS

The deadweight analysis should consider the piping and component weight, the insulation weight and the weight of fluids contained in the system.

THERMAL EXPANSION ANALYSIS

A thermal expansion analysis is recommended if one of the following conditions applies:

- The operating or maximum fluid temperature exceeds 150°F
- The piping is attached to equipment which has nozzle load criteria
- The piping flexibility is judged insufficient to accommodate thermal expansion.

Thermal expansion analysis should include header and equipment resultant thermal movements at the terminal and nozzle attachment points.

Thermal analysis shall consider the potential for flow stratification in horizontal lines subjected to low flow velocities and large temperature gradients from top to bottom of pipe, with a Richardson number $R_i > 1$, where:

$$R_i = \left(\frac{d\rho}{\rho}\right)\left(\frac{gD_i}{v^2}\right)$$

where:

ρ = density of fluid (a function of temperature)

$d\rho$ = change in fluid density between max and min. temperature (top to bottom of pipe)

g = gravitational constant

D_i = pipe inside diameter

v = flow velocity

PRESSURE ANALYSIS

This Appendix does not address the requirement for system sizing and process design such as pipe size (and minimum wall thickness), component ratings, reinforcement of openings, layout arrangements (including pressure relief) and testing (such as hydrostatic pressure testing). These requirements should be specified in the project or design documents, or referred to the applicable Code. Refer to Appendix A.

SEISMIC ANALYSIS

When seismic analysis is required, this analysis may be accomplished using static or dynamic methods, as permitted in the project specification.

STATIC SEISMIC ANALYSIS

The static seismic analysis is applied to a system or subsystem.

A static load should be calculated in accordance with the applicable standard (such as IBC) and is applied to the piping system, in each of three directions.

If the piping system is rigid, the static load may be equal to the envelope of the floor response spectra zero period accelerations.

The system response to each of the three one-directional static loadings shall be combined by SRSS to obtain the resultant system response, unless permitted otherwise by the applicable standard (for example, IBC-2000 permits a two-dimensional load combination, where the resultant seismic load is the largest of the east-west + vertical and north-south + vertical).

RESPONSE SPECTRA MODAL ANALYSIS

The applicable response spectra should envelope the spectra at all attachment points along the piping system, including the supports from decoupled headers, in the vicinity of the decoupled branch point.

The three directional response should be calculated by SRSS of the three unidirectional responses.

Modal combination should be by SRSS of modes, unless specified otherwise in the project requirements.

High frequency modes (beyond the zero period acceleration or 33 hertz) should be accounted for as described in USNRC Standard Review Plan NUREG-0800, Section 3.7.2.

Seismic anchor motions larger than ¼ inch should be evaluated.

The following considerations apply for the dynamic model of the piping system:

1) The number of dynamic degrees of freedom, and hence the number of lumped masses, should be selected so that all significant modes of vibration of the structure below 33 Hz are accurately represented. The location of masses will be dependent upon the piping support configuration. In addition, mass points should be established at concentrated weight locations (e.g., valves, flanges, large fittings) and at the centerline of eccentric masses (such as valve operators).

411 If a support mass is larger than 20% of an adjacent pipe lumped mass, the support mass should be considered in the model.

412 Valves with natural frequencies below the zero period acceleration shall be modeled to appropriately reflect their actual mass and frequency.

Damping of piping system for seismic Design Basis Earthquake response spectra modal analysis shall be 5% unless specified otherwise in project requirements.

TIME HISTORY ANALYSIS

Seismic time history analysis of a piping system should only be used as a last resort, where some of the conservatism inherent to the static or response spectra methods must be eliminated.

The analysis may be performed using either the direct integration procedure or the modal superposition procedure. In both approaches, careful consideration should be given to the numerical integration method being used and the time step of integration. The time step (dt) chosen should be sufficiently small to capture the significant portion of response and to ensure that excessive numerical damping is not being introduced into the response calculations

For modal time-history superposition, care should be taken to ensure that all the significant modes of vibration are included in the analysis.

Responses from the individual modes of vibration included in the analysis may be combined by algebraic summation of the modal time histories of response at each time step to determine the individual component response time history.

The damping and energy dissipation shall be simulated using applicable procedures of Appendix N of ASME B&PV Code Section III.

When the three components of earthquake motion are statistically independent, time-history responses may be obtained individually for each of the three independent components and combined algebraically at each time step to obtain the combined response time history.

FLUID TRANSIENT ANALYSIS

Loads resulting from fluid transients (such as opening and closing of valves, startup and coast down of pumps) should be considered if they are anticipated occurrences from normal operation of the system.

Fluid transients resulting from Design Basis Accidents should be identified in the project design documents, and analyzed accordingly.

Unanticipated transients (transients which do not result from normal operation of the system) need not be analyzed, and should be precluded by proper operating, maintenance and testing procedures.

WIND DESIGN

Wind design shall be considered for outdoor piping. Wind loads should be applied as a uniformly distributed load of magnitude and direction defined in the project Functional Design Criteria or Design Documents. Refer to ASCE 7-95 for reference methods.

PIPING SYSTEM QUALIFICATION

The requirements of the applicable code shall apply, for the load combinations defined with the following additions and clarifications:

For B31.1 piping, and B31.3 piping analyzed to B31.1 rules, the allowable stress for faulted loading should be the minimum of $3S_h$ or $2S_y$.

Higher allowables may be considered based on detailed analysis per ASME III NB-3200.

Where stress indices and stress intensification factors are not defined in the Code, they must be justified on a case basis.

Faulted seismic anchor motion amplitudes should be included in the qualification of piping faulted primary stress. Alternatively, half the faulted seismic anchor motion amplitude may be added to the thermal stress range.

The compliance of piping stress to code allowables insures that the piping cross section and pressure boundary remain intact. In addition, requirements for equipment and component operability or integrity need to apply.

Higher allowables or alternate evaluation methods may be used for piping systems that only need to retain structural integrity (not fall).

QUALIFICATION OF IN-LINE EQUIPMENT AND COMPONENTS

QUALIFICATION OF ACTIVE VALVES AND IN-LINE COMPONENTS

The acceleration of active valve/s (i.e., valves which are required to change state during or after the DBE, excluding check valves) and in-line components should be limited to values provided by the vendor. When allowable valve and component accelerations are not provided, a limit of 3g resultant horizontal and 3g (including 1g from deadweight) vertical should apply at the center of gravity of the actuator.

The nozzle loads on active valves and in-line components should be limited to values specified by the vendor. Where allowable nozzle loads are not specified, the pipe stress at the valve and component nozzle considering pipe cross-section properties should meet the pipe stress allowables.

The rules of the DOE-EH-0545 may be used for verification of seismic adequacy of existing (installed) piping mounted components for existing systems.

Flange Qualification

Flanges should be qualified using the methods specified in B31.1 or B31.3.

Equipment Nozzle Loads

The nozzle loads on equipment should be limited to values specified by the vendor or derived by analysis. Where allowable nozzle loads are not specified, the pipe stress at the equipment nozzle shall meet the pipe stress allowables. Where no vendor limits are specified, the total stress (primary plus secondary) shall not exceed $0.3S_h$ at the nozzle of rotating equipment unless justified on a case basis.

Protection Against Seismic Interactions

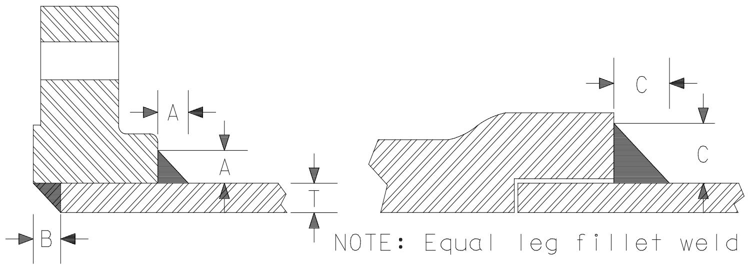
The seismic qualification of a piping system requires its protection from credible and significant interactions, and spatial interactions (falling objects or impact interference with adjacent structures).

Expansion Joints

Expansion joints should be qualified by comparison of calculated displacements to vendor allowables or by analysis to the rules of the Expansion Joint Manufacturers Association as specified in the applicable ASME B31.1 or B31.3.

APPENDIX J – FILLET WELD SIZES

The following table provides a convenient reference of the sizes of fillet weld that are required by both the ASME B31.1 and B31.3 piping codes.



					SO & SW FLANGE			FITTINGS
NPS	**Sched**	**T**	**1.09 T**	**1.4 T**	**A(B31.1)**	**A(B31.3)**	**B**	**C**
1/8	10s	0.049	0.053	0.069				1/8
	40	0.068	0.074	0.095				1/8
	80	0.095	0.104	0.133				1/8
¼	10s	0.065	0.071	0.091	1/8	1/8		1/8
	40	0.088	0.096	0.123	1/8	1/8		1/8
	80	0.119	0.130	0.167	3/16	3/16		3/16
3/8	10s	0.065	0.071	0.091	1/8	1/8		1/8
	40	0.091	0.099	0.127	1/8	3/16		1/8
	80	0.126	0.137	0.176	3/16	3/16		3/16
½	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.083	0.090	0.116	1/8	1/8	T	1/8
	40	0.109	0.119	0.153	1/8	3/16	T	1/8
	80	0.147	0.160	0.206	3/16	¼	T	3/16
	160	0.188	0.205	0.263	¼	5/16	T	¼
	xx	0.294	0.320	0.412	3/8	7/16	¼	3/8
¾	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.083	0.090	0.116	1/8	1/8	T	1/8
	40	0.113	0.123	0.158	1/8	3/16	T	1/8
	80	0.154	0.168	0.216	3/16	¼	T	3/16
	160	0.219	0.239	0.307	¼	5/16	T	¼
	xx	0.308	0.336	0.431	3/8	7/16	¼	3/8
1	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.109	0.119	0.153	1/8	3/16	T	1/8
	40	0.133	0.145	0.186	3/16	¼	T	3/16
	80	0.179	0.195	0.251	¼	5/16	T	¼
	160	0.250	0.273	0.350	5/16	3/8	¼	5/16
	xx	0.358	0.390	0.501	7/16	9/16	¼	7/16
1 ¼	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.109	0.119	0.153	1/8	3/16	T	1/8
	40	0.140	0.153	0.196	3/16	¼	T	3/16
	80	0.191	0.208	0.267	¼	5/16	T	¼
	160	0.250	0.273	0.350	5/16	3/8	¼	5/16
	xx	0.382	0.416	0.535	7/16	9/16	¼	7/16
1 ½	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.109	0.119	0.153	1/8	3/16	T	1/8
	40	0.145	0.158	0.203	3/16	¼	T	3/16
	80	0.200	0.218	0.280	¼	5/16	T	¼

					SO & SW FLANGE			FITTINGS
NPS	**Sched**	**T**	**1.09 T**	**1.4 T**	**A(B31.1)**	**A(B31.3)**	**B**	**C**
	160	0.281	0.306	0.393	5/16	7/16	¼	5/16
	xx	0.400	0.436	0.560	7/16	9/16	¼	7/16
2	5s	0.065	0.071	0.091	1/8	1/8	T	1/8
	10s	0.109	0.119	0.153	1/8	3/16	T	1/8
	40	0.154	0.168	0.216	3/16	¼	T	3/16
	80	0.218	0.238	0.305	¼	5/16	T	¼
	160	0.344	0.375	0.482	3/8	½	¼	3/8
	xx	0.436	0.475	0.610	½	5/8	¼	½
2 ½	5s	0.083	0.090	0.116	1/8	1/8	T	1/8
	10s	0.120	0.131	0.168	3/16	3/16	T	3/16
	40	0.203	0.221	0.284	¼	5/16	T	¼
	80	0.276	0.301	0.386	5/16	7/16	¼	5/16
	160	0.375	0.409	0.525	7/16	9/16	¼	7/16
	xx	0.552	0.602	0.773	5/8	13/16	¼	5/8
3	5s	0.083	0.090	0.116	1/8	1/8	T	1/8
	10s	0.120	0.131	0.168	3/16	3/16	T	3/16
	40	0.216	0.235	0.302	¼	5/16	T	¼
	80	0.300	0.327	0.420	3/8	7/16	¼	3/8
	160	0.438	0.477	0.613	½	5/8	¼	½
	xx	0.600	0.654	0.840	11/16	7/8	¼	11/16
3 ½	5s	0.083	0.090	0.116	1/8	1/8	T	1/8
	10s	0.120	0.131	0.168	3/16	3/16	T	3/16
	40	0.226	0.246	0.316	¼	5/16	T	¼
	80	0.318	0.347	0.445	1/8	½	¼	3/8
4	5s	0.083	0.090	0.116	1/8	1/8	T	1/8
	10s	0.120	0.131	0.168	3/16	3/16	T	3/16
	40	0.237	0.258	0.332	5/16	3/8	T	5/16
	80	0.337	0.367	0.472	3/8	½	¼	3/8
	120	0.438	0.477	0.613	½	5/8	¼	½
	160	0.531	0.579	0.743	5/8	¾	¼	5/8
	xx	0.674	0.735	0.944	¾	1	¼	¾
5	5s	0.109	0.119	0.153	1/8	3/16	T	
	10s	0.134	0.146	0.188	3/16	3/16	T	
	40	0.258	0.281	0.361	5/16	3/8	¼	
	80	0.375	0.409	0.525	7/16	9/16	¼	NA
	120	0.500	0.545	0.700	9/16	¾	¼	
	160	0.625	0.681	0.875	11/16	7/8	¼	
	xx	0.750	0.818	1.050	7/8	1 1/16	¼	
6	5s	0.109	0.119	0.153	1/8	3/16	T	
	10s	0.134	0.146	0.188	3/16	3/16	T	
	40	0.280	0.305	0.392	5/16	7/16	¼	
	80	0.432	0.471	0.605	½	5.8	¼	NA
	120	0.562	0.613	0.787	5/8	13/16	¼	
	160	0.719	0.784	1.007	13/16	1 1/16	¼	
	xx	0.864	0.942	1.210	1	1 ¼	¼	
8	5s	0.109	0.119	0.153	1/8	3/16	T	
	10s	0.148	0.161	0.207	1/8	¼	T	
	20	0.250	0.273	0.350	3/16	3/8	¼	
	30	0.277	0.302	0.388	5/16	7/16	¼	
	40	0.322	0.351	0.451	3/8	½	¼	
	60	0.406	0.443	0.568	½	5/8	¼	NA
	80	0.500	0.545	0.700	9/16	¾	¼	
	100	0.594	0.647	0.832	11/16	7/8	¼	
	120	0.719	0.784	1.007	13/16	1 1/16	¼	
	140	0.812	0.885	1.137	15/16	1 3/16	¼	
	160	0.906	0.988	1.268	1	1 5/16	¼	
	xx	0.875	0.954	1.225	1	1 ¼	¼	

					SO & SW FLANGE			FITTINGS
NPS	Sched	T	1.09 T	1.4 T	A(B31.1)	A(B31.3)	B	C
10	5s	0.134	0.146	0.188	1/8	3/16	T	
	10s	0.165	0.180	0.231	3/16	¼	T	NA
	20	0.250	0.273	0.350	5/16	3/8	¼	
10	30	0.307	0.335	0.430	3/8	7/16	¼	
	40	0.365	0.398	0.511	7/16	9/16	¼	
	60	0.500	0.545	0.700	9/16	¾	¼	
	80	0.594	0.647	0.832	11/16	7/8	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	NA
	100	0.719	0.784	1.007	13/16	1 1/16	¼	
	120	0.844	0.920	1.182	15/16	1 3/16	¼	
	140	1.000	1.090	1.400	1 1/16	1 7/16	¼	
	160	1.125	1.226	1.575	1 ¼	1 5/8	¼	
	xx	1.000	1.090	1.400	1 1/8	1 7/16	¼	
12	5s	0.156	0.170	0.218	3/16	¼	T	
	10s	0.180	0.196	0.252	¼	5/16	T	
	20	0.250	0.273	0.350	5/16	3/8	¼	
	30	0.250	0.360	0.462	3/8	½	¼	
	40	0.330	0.443	0.568	½	5/8	¼	
	40s	0.406	0.409	0.525	7/16	9/16	¼	
	STD	0.375	0.409	0.525	7/16	9/16	¼	
	60	0.562	0.613	0.787	5/8	13/16	¼	NA
	80	0.688	0.750	0.963	¾	1	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	0.844	0.920	1.182	15/16	1 3/16	¼	
	120	1.000	1.090	1.400	1 1/8	1 7/16	¼	
	140	1.125	1.226	1.575	1 ¼	1 5/8	¼	
	160	1.312	1.430	1.837	1 7/16	1 7/8	¼	
	x	0.500	0.545	0.700	9/16	¾	¼	
	xx	1.000	1.090	1.400	1 1/8	7/16	¼	
14	5s	0.156	0.170	0.218	3/16	¼	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	
	10s	0.188	0.205	0.263	¼	5/16	T	
	20	0.312	0.340	0.437	3/8	7/16	¼	
	30	0.375	0.409	0.525	7/16	9/16	¼	
	40	0.438	0.477	0.613	½	5/8	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	NA
	60	0.594	0.647	0.832	11/16	7/8	¼	
	80	0.750	0.818	1.050	7/8	1 1/16	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	0.938	1.022	1.313	1 1/16	1 5/16	¼	
	120	1.094	1.192	1.532	1 ¼	1 9/16	¼	
	140	1.250	1.363	1.750	1 3/8	1 ¾	¼	
	160	1.406	1.533	1.968	1 9/16	2	¼	
	x	0.500	0.545	0.700	9/16	¾	¼	
16	5s	0.165	0.180	0.231	3/16	¼	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	
	10s	0.188	0.205	0.263	¼	5/16	T	
	20	0.312	0.340	0.437	3/8	7/16	¼	
	30	0.375	0.409	0.525	7/16	9/16	¼	
	40	0.500	0.545	0.700	9/16	¾	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	NA
	60	0.656	0.715	0.918	¾	15/16	¼	
	80	0.844	0.920	1.182	15/16	1 3/16	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	1.031	1.124	1.443	1 1/8	1 ½	¼	
	120	1.219	1.329	1.707	1 3/8	1 ¾	¼	
	140	1.438	1.567	2.013	1 9/16	2 1/16	¼	

					SO & SW FLANGE			FITTINGS
NPS	**Sched**	**T**	**1.09 T**	**1.4 T**	**A(B31.1)**	**A(B31.3)**	**B**	**C**
	160	1.594	1.737	2.232	1 ¾	2 ¼	¼	
18	5s	0.165	0.180	0.231	3/16	¼	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	NA
	10s	0.188	0.205	0.263	¼	5/16	T	
	20	0.312	0.340	0.437	3/8	7/16	¼	
18	STD	0.375	0.409	0.525	7/16	9/16	¼	
	30	0.438	0.477	0.613	½	5/8	¼	
	40	0.562	0.613	0.787	5/8	13/16	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	
	60	0.750	0.818	1.050	7/8	1 1/16	¼	
	80	0.938	1.022	1.313	1 1/16	1 3/8	¼	NA
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	1.156	1.260	1.618	1 5/16	1 5/8	¼	
	120	1.375	1.499	1.925	1 ½	1 15/16	¼	
	140	1.562	1.703	2.187	1 ¾	2 3/16	¼	
	160	1.781	1.941	2.493	2	2 ½	¼	
	x	0.500	0.545	0.700	9/16	¾	¼	
20	5s	0.188	0.205	0.263	¼	5/16	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	
	10s	0.218	0.238	0.305	¼	5/16	T	
	20	0.375	0.409	0.525	7/16	9/16	¼	
	30	0.500	0.545	0.700	9/16	¾	¼	
	40	0.594	0.647	0.832	11/16	7/8	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	NA
	60	0.812	0.885	1.137	15/16	1 3/16	¼	
	80	1.031	1.124	1.443	1 1/8	1 ½	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	1.281	1.396	1.793	1 7/16	1 13/16	¼	
	120	1.500	1.635	2.100	1 11/16	2 1/8	¼	
	140	1.750	1.908	2.450	1 15/16	2 ½	¼	
	160	1.969	2.146	2.757	2 13/16	2 13/16	¼	
22	5s	0.188	0.205	0.263	¼	5/16	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	
	10s	0.218	0.238	0.305	5/16	5/16	T	
	20	0.375	0.409	0.525	7/16	9/16	¼	
	30	0.500	0.545	0.700	9/16	¾	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	NA
	60	0.875	0.954	1.225	1	1 ¼	¼	
	80	1.125	1.226	1.575	1 ¼	1 5/8	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	1.375	1.499	1.925	1 ½	1 15/16	¼	
	120	1.625	1.771	2.275	1 13/16	2 5/16	¼	
	140	1.975	2.153	2.765	2 3/16	2 13/16	¼	
	160	2.125	2.316	2.975	2 3/8	3	¼	
24	5s	0.218	0.238	0.305	5/16	5/16	T	
	10	0.250	0.273	0.350	5/16	3/8	¼	
	10s	0.250	0.273	0.350	5/16	3/8	¼	
	20	0.375	0.409	0.525	7/16	9/16	¼	
	30	0.562	0.613	0.787	5/8	13/16	¼	
	40	0.688	0.750	0.968	¾	1	¼	
	40s	0.375	0.409	0.525	7/16	9/16	¼	
	60	0.969	1.056	1.357	1 1/16	1 3/8	¼	NA
	80	1.219	1.329	1.707	1 3/8	1 ¾	¼	
	80s	0.500	0.545	0.700	9/16	¾	¼	
	100	1.531	1.669	2.143	1 11/16	2 3/16	¼	
	120	1.812	1.975	2.537	2	2 9/16	¼	
	140	2.062	2.248	2.887	2 ¼	2 15/16	¼	

					SO & SW FLANGE			FITTINGS
NPS	**Sched**	**T**	**1.09 T**	**1.4 T**	**A(B31.1)**	**A(B31.3)**	**B**	**C**
	160	2.344	2.555	3.282	2 9/16	3 5/16	¼	
	x	0.500	0.545	0.700	9/16	¾	¼	
30	10	0.312	0.340	0.437	3/8	7/16	¼	
	STD	0.375	0.409	0.525	7/16	9/16	¼	NA
	20	0.500	0.545	0.700	9/16	¾	¼	
	30	0.625	0.681	0.875	11/16	7/8	¼	

NOTES:

1. The A, B, and C dimensions are the minimum fractional dimensions that satisfy the Codes. A(B31.1) is 1.09T raised to next higher 1/16". A(B31.3) is 1.4T raised to next higher 1/16".
2. T is defined as the nominal pipe wall thickness.
3. The A dimension is the lesser of A or the thickness of the hub.
4. The C dimension is the lesser of C as listed herein or the thickness of the socket wall.
5. This table is not applicable when pipe is purchased to other than schedule, standard, XS, and XXS wall thicknesses.

APPENDIX K – CLEANING CARBON AND STAINLESS STEEL PIPE

GENERAL

The various types of contamination and the methods suitable for their removal are listed in Table 1. Reference ASTM A380 for more information on cleaning and descaling stainless steels.

Information on the types of contamination that must be removed shall be obtained from project specifications or consultation with the appropriate design authority.

The amount of free iron contamination that can be tolerated and the extent of the surface area to be tested shall be specified by the appropriate Design Authority.

INSPECTION

All pipe cleaned in accordance with this Appendix should be inspected to determine the effectiveness of the cleaning method used.

Cleaning methods that are employed solely for the removal of dirt, paint, metal chips, filings, flux, slag, weld spatter, scale, rust, or other types of contamination that are easily seen should be visually inspected with the unaided eye to ensure that the contaminants have been removed. This inspection should include interior surfaces.

When cleaning methods are used for the purpose of removing grease, oil, waxes, or other contaminants that may exist as a thin film, items should be wiped with a clean, white, solvent dampened cloth to ensure that the contamination has been removed.

Removal of free iron contamination should be confirmed through the use of a ferroxyl test. The ferroxyl test is highly sensitive and is required only when traces of free iron or iron oxide would be unacceptable. 400 Series stainless steels may contain a gray smut after acid treatments. This smut must be removed by a thorough washing using water, detergent, and scrub brushes before ferroxyl testing, or the test will be positive.

SAFETY

Use of compressed air creates a hazard from flying particles. Use proper eye protection.

Mechanical cleaning with power tools using wire brushes, grinding wheels, and sanding attachments presents hazards from flying particles and rotating shafts. Use protective clothing and eye protection, and ensure that clothing will not become entangled in the equipment.

Abrasive blast cleaning presents hazards to personnel. Protective clothing, eye protection, and in some cases respiratory protection are required for safe operation.

Use of acids and cleaning agents presents hazards to the environment and personnel. Environmental restrictions on the use and disposal of cleaning solutions must be adhered to. Face shields, rubber gloves, protective clothing, and respiratory protection may be required when using corrosive chemicals and proprietary cleaners. Consideration should be given to the proximity of safety showers and eyewash stations.

CLEANING METHODS

Method A-1, Water Flush.

Flush pipe with clean water, on stainless steel use only water having a chloride content less than 50 ppm for the final flush. (Note: domestic water generally contains less than 2 ppm chlorides).

Dry to conform to system requirements.

Method A-2, Steam or Air Blow

Blow pipe with clean, dry, compressed air or steam. Use sufficient volume of air to create a high velocity stream in the pipe. If air is supplied form compressors, they shall be equipped with moisture separators, oil separators, traps, and/or filters, as required to ensure that the air is clean and dry.

Method B, Steam Cleaning.

Use steam at pressures from 50 to 75 psi in conjunction with cleaning agents such as emulsions, detergents, solvents, and alkalis. Proprietary cleaners may contain harmful ingredients such as chlorides or sulfur, which may adversely affect the material to be cleaned, especially in the case of stainless steel. The manufacturer of the cleaning agent should be contacted prior to its use when any doubt exists.

Drain pipe and flush with clean water, use chloride free water on stainless steel. (See method A-1)

Blow dry with clean, dry, compressed air. (See method A-2)

Method C-1, Blast Cleaning

Clean, previously unused glass beads, iron free silica, walnut shells, or alumina sand are required for abrasive blasting of stainless steel pipe. For carbon steel pipe use sand, steel shot, or steel grit. Blast clean inside and outside surfaces as required.

Use clean, dry, compressed air. (See method A-2)

Follow with procedure A-1 or A-2.

Method C-2, Mechanical Cleaning

Wire brushing, sanding, and grinding are suitable methods for localized removal of scale and spatter left by welding. Stainless steel wire brushes are required for use on stainless steel pipe. Grinding wheels, wire brushes, and sanding materials containing iron, iron oxide, or zinc, or those previously used on other metals, shall not be used to clean stainless steel pipe.

Method D-1, Dehydration of Carbon Steel Pipe for Low Temperature Service Using Nitrogen

This procedure is recommended for removal of small amounts of moisture that may exist in a nominally dry system.

Evacuate system to an absolute pressure of 5 mm of mercury or less. If it is necessary to dehydrate an outdoor system when the temperature is less than 36^0 F, special precautions must be taken to ensure proper dehydration. These may include sweeping with dry gas, circulating warm water or brine, blanketing of equipment, or using electric resistance heaters.

Difficulty in achieving the required vacuum may be due to presence of excess moisture in the system, leakage of air into the system, a faulty or inadequate vacuum pump, or the presence of absorbed refrigerant or moisture in the vacuum pump oil.

If a leak is the suspected cause of insufficient vacuum, perform a leak test of the required sensitivity to locate the leak(s) and repair.

When the required vacuum is reached, isolate the vacuum pump and let the system stand for a minimum of 4 hours. A pressure rise of not more than .4mm of mercury during this period will indicate sufficient dehydration. After the system is completely dehydrated, charge it with an inert dry gas suitable to the use of the line. Build up pressure to 50% of design pressure, tag and seal the system until start-up.

Method D-2, Dehydration of Carbon Steel Pipe for Low Temperature Service by the Alcohol Method

This procedure is recommended where small amounts of water are suspected in the system, such as in pockets, fittings, and valves.

Drain and dry the system with clean, dry, compressed air. Use resistance testing to ensure that the system is completely statically grounded.

Fill the system with alcohol (methanol preferred). Make sure all high spots are vented, and the system is completely wetted with alcohol, then completely drain the alcohol from the system.

Pull a vacuum on the system, test and fill with inert gas per procedure D-1 above.

Method E-1, Sulfuric Acid Cleaning of Carbon Steel Pipe

Acid cleaning is not effective for removal of greases, oils, and waxes. Surfaces should be pre-cleaned using method B.

Pickle with a solution containing 5 to 10 weight percent inhibited sulfuric acid until all scale and rust are removed (pickling times of 15 to 20 minutes are normal). Heat and maintain pickling solution between 160^0F and 180^0F.

Pump solution through pipe or immerse in a pickling tank. Immediately flush with clean water followed by a hot water rinse containing one half ounce per gallon of sodium carbonate (Na_2CO_3) or tri-sodium phosphate (TSP -- Na_3PO_4).

Flush with rust inhibitor consisting of 0.5% sodium nitrite ($NaNO_2$), 0.25% disodium phosphate (Na_2HPO_4) and 0.25% monosodium phosphate (NaH_2PO_4). Dry to conform to system requirements.

Methods F-1 Through 13, Use of Acid for Descaling or Cleaning Stainless Steel

General

Descaling is the removal of heavy, tightly adherent oxide films resulting from hot-forming, heat treatment, welding and other high-temperature operations. Descaling methods are outlined in Table 2, Part I. Cleaning is the removal of surface contaminants to enhance appearance and corrosion resistance, and to prevent the contamination of product. Cleaning methods are outlined in Table 2, Parts II and III. Passivation is generally not needed except in cases where the material will not be exposed to air or other oxygen containing environment long enough to establish a passive film. Cleaning and Passivation methods are listed in Table 2, Part III.

Precautions

Exposure to the descaling solutions in Table 2, Part I, for more than 30 minutes must be avoided. Drain and rinse the item and re-apply the treatment if required. Intermittent scrubbing with a stainless steel or fiber brush may facilitate the removal of heavy scale.

Use of nitric-hydrofluoric acid solutions on stainless steel may produce intergranular attack in cases where the metal has been sensitized by welding or improper heat treatment. This can lead to stress corrosion cracking under service conditions, and is not recommended. In the case of weldments, only those of the low carbon and stabilized grades may be safely treated with these solutions.

Hardenable 400 Series, managing, and precipitation hardening alloys in the hardened condition are subject to intergranular attack and hydrogen embrittlement when exposed to acids. Use mechanical or other chemical methods whenever possible. If acid treatment is unavoidable, parts shall be heated to 250 - 300^0F for 24 hours to drive off hydrogen.

Severe pitting may result from prolonged exposure to acid solutions if the solution becomes depleted or if the concentration of metallic salts becomes too high as a result of prolonged use of the solution. For the methods in Table 2, part I, limit dissolved iron concentration to 5 weight %. Limit the concentration of dissolved iron to 2 weight % for all other methods listed in Table 2.

Method for Using Acid Solutions to Clean and Descale Stainless Steel

Acid treatments are not effective for removal of greases, oils, and waxes. Surfaces should be pre-cleaned using procedure B if these contaminants are present.

Select appropriate treatment from Table 2. Total immersion is the preferred method of application, but the acid solution may be circulated around or through the item, or the item may be swabbed or sprayed so that all surfaces receive the required treatment.

All items exposed to acid solutions must be thoroughly rinsed at the completion of the treatment. To minimize staining, the item must not be allowed to dry between steps. If necessary, a neutralizer solution may be used, followed by a final hot water rinse. Final rinse water shall contain less than 50 ppm chlorides.

Items are to be thoroughly dried after final rinsing.

References

1) KIE Freon Refrigeration System, Leak Testing, Dehydration and Charging

2) Steel Structures Painting Council:

Systems and Specifications, Steel Structures Painting Manual, Volume 2

Good Painting Practice, Volume 1, Chapter 3.2 Pickling Steel Surfaces.

Tables

Table 1 - Contamination Types and Removal Procedures

Table 2 - Cleaning and Descaling Stainless Steel

TABLE 1 - CONTAMINATION TYPES AND REMOVAL PROCEDURES

Types of Contamination	Removal Procedures
Dirt, Metal Chips, and Filings	A-1, A-2, B
Oil, Paint, Grease Wax, Varnish	B
Moisture	D-1, D-2
Weld Spatter, Rust, Scale, Slag, Free Iron	C-1, C-2, E-1, E-2, F-1 through 13

TABLE 2 -- CLEANING AND DESCALLING STAINLESS STEEL					
		Treatment			
Alloy	Condition	Method	Solution Volume%[B]	Temperature P	Time, Minutes
Part 1 Acid Descaling of Stainless Steel					
200, 300, and 400 Series, precipitation hardening and managing alloys (except free machining alloys).[A]	fully annealed only	F-1	H_2SO_3, 8-11% Follow by method F-4 or F-6	150-180	5-45 max[D]
200 and 300 Series, 400 Series containing Cr 16% or more, precipitation-hardening alloys (except free machining alloys). [A]	fully annealed only	F-2	HNO_3, 15-25% plus HF 1-8%[F]	70-140 max	6-30[D]
All free machining alloys and 400 Series containing less than Cr 16%. [A]	fully annealed only	F-3	HNO_3 10-15% plus HF 0.5-1.5%[F]	70 (up to 140 with caution)	6-30[D]
Part II Cleaning With Nitric-Hydrofluoric Acid					
200 and 300 Series, 400 Series containing 16% Cr or more, and precipitation hardening alloys (except free machining alloys).	fully annealed only	F-4	HNO_3, 6-25% plus HF 0.5-8%[E,F]	70-140	as necessary
Free machining alloys, maraging alloys, and 400 Series containing less than Cr 16%.	fully annealed only	F-5	HNO_3, 10% plus HF 0-5-1.5%[E,F]	70 (up to 140 with caution)	1-2
Part IIII Cleaning and Passivation with Nitric Acid Solution					
200 and 300 Series, 400 Series, precipitation hardening and maraging alloys containing 16% Cr or more (except free-machining alloys).[G]	annealed, cold rolled or work hardened, with dull or non-reflective surfaces	F-6	HNO_3, 20-50%	120-160 70-100	10-30 30-60[F]
	annealed, cold rolled or work hardened, with bright machined or polished surfaces	F-7	HNO_3, 20-40% plus $Na_2Cr_2O_7$. $2H_20$, 2-6 weight %	120-155 70-100	10-30 30-60[F]
400 Series, maraging and precipitation hardening alloys containing less than Cr 16%, high carbon straight Cr alloys (except free machining alloys).[G]	annealed or hardened with dull or non-reflective surface	F-8	HNO_3, 20-50%	110-130 70-100	15-30 60
	annealed or hardened with bright machined or polished surfaces	F-9	HNO_3, 20-25% plus $Na_2Cr_2O_7$. $2H_20$, 2-6 weight %	120-130 70-100	20-30 30-60
200, 300, 400 Series free-machining alloys.[G]	annealed or hardened with bright machined or polished surfaces	F-10[I]	HNO_3, 20-50% plus $Na_2Cr_2O_7$. $2H_20$, 2-6 weight %	70-120	25-30
		F-11[H]	HNO_3, 1-2% plus $Na_2Cr_2O_7$. $2H_20$, 1-5 weight %	120-140	10
		F-12	HNO_3, 12% plus $CuSo_4$. SH_2O, 4 weight %	120-140	10
Special free machining 400 Series alloys with more than Mn 1.25%, or more than 0.40%.[G]	annealed or hardened with bright machined or polished surfaces	F-13	HNO_3, 40-60% plus $Na_2Cr_2O_7$. $2H_20$, 2-6 weight %	110-130	20-30

Notes:

[A]This is also applicable to the cast grades equivalent to the families of wrought materials listed.

[B]Solution prepared form reagents of the following weight %: H_2SO_4 98, HNO_3, 67, HF, 70.

[C]Tight scale may be removed by a dip in this solution for a few minutes, followed by a water rinse and nitric-hydrofluoric treatment as noted.

[D]Minimum contact times necessary to obtain the desired surfaces should be used in order to prevent over pickling. Tests should be made to establish correct procedure for specific applications.

[E]For reasons of convenience and handling safety, commercial formulations containing fluoride salts may be used in place of HF for preparing nitric-hydrofluoric acid solutions.

[F]After pickling and water rinsing, an aqueous caustic pemanganate solution containing NaOH, 10 weight%, and KM_nO_4, 4 weight %, 160-180 F, 5-60 minutes, may be used as a final dip for removal of smut, followed by a thorough rinsing and drying.

[G]As an option, all 400 Series ferritic or martenitic parts may receive additional treatment as follows: within one hour after the water rinse following the specified passivation treatment, all parts shall be immersed in an aqueous solution containing 4 to 6 weight % $Na_2Cr_2O_7 \bullet 2H_2O$ at 140 to 160^0F for 30 minutes. This immersion shall be followed by a through rinsing with clean water, and thoroughly dried.

[H]Shorter times may be acceptable where established by test.

[I]High carbon and free machining alloys may be subject to etching or discoloration, use higher acid concentrations to minimize this.

If fresh attack (clouding on stainless steel surface) occurs, a fresh (clean) passivating solution or a higher HNO concentration will usually eliminate it.

APPENDIX L – BURIED PROCESS PIPE

SPECIAL CONSIDERATIONS FOR BURIED PROCESS PIPE

Engineering and Construction must consider the following factors to assure safe operation of a buried piping system:

A. The selection of the proper pipe material, coating and lining and their compatibility with soil and fluid (input from Materials Engineer, Vendor and past practice).

B. The judicious routing of the pipe to minimize natural risks such as soil settlement, flood or frost (input from Geotechnical Engineer).

C. The structural design of the piping system (further discussed in this Appendix).

D. The proper trench preparation and pipe laying (further discussed in this Appendix).

E. The joining method and the quality of fabrication, examination and pressure testing which must comply with ASME B31.3 if the piping is part of a process system.

F. The operation, periodic inspection and maintenance of the system.

G. The use of line markers, sufficient ground cover and controls to avoid excavation damage.

CONSTRUCTION

The Fabrication, Examination and Inspection requirements of ASME B31.3 apply.
In addition, special provisions from Federal, State, local and Site requirements apply.
Non-Process Standards provide useful guidance; they include:
AWWA C206 Field Welding of Steel Water Pipe
AWWA Standard C600, Installation of Ductile-Iron Water Mains and their Appurtenances.
AWWA Manual M23 PVC Pipe - Design and Installation
AWWA Manual M11 Steel Pipe
ASCE Manual No 60 Gravity Sanitary Sewer Design and Construction

DESIGN OF BURIED PROCESS PIPE

LOADS ON BURIED PIPE

Soil and Surface loads consist of Internal Pressure, Restrained Thermal Growth or Contraction, Soil Settlement, Waterhammer, and Seismic (wave passage and differential movements) as applicable.

Design guidance for buried steel pipe may be found in “Design of Buried Steel Pipe,” (www.americanlifelinesalliance.org).

APPENDIX M – MITERED JOINTS

The equations provided below may be used to determine the maximum allowable internal pressure for mitered bends using the methods prescribed by ASME B31.3 paragraph 304.2.3. The designer performing these calculations should review the B31.3 Code to ensure he understands all the required details.

NOTE: Mathcad shells for performing these calculations for maximum internal pressure in single and multiple miter bends are available from the ESM Mechanical POC.

Step 1

Determine the total mechanical allowance (c) including the erosion and corrosion for the system in inches.

Step 2

Determine the material allowable stress (S) at the design temperature from Appendix A, B31.3 in psi.

Step 3

Determine the joint quality factor (E) from Appendix A, B31.3. For seamless pipe, E=1.

Step 4

Determine the outer diameter (D) and nominal wall thickness (T_{nom}) of the mitered pipe.

Step 5

Determine the geometric design configuration data: R_1 is the radius of curvature measured to the centerline of the pipe, θ is the angle of the mitered cut in degrees. See B31.3 Figure 304.2.3 for nomenclature. R_1 shall not be less than that calculated be equation M-1.

$$R_1 = \frac{A}{\tan\theta} + \frac{D}{2} \qquad \text{(M-1)}$$

where A has the following empirical values:

(T-c), in.	A
≤0.5	1.0
0.5<(T-c)<0.88	2(T-c)
≥0.88	[2(T-c)/3]+1.17

Step 6

Calculate the minimum pipe wall thickness (nominal thickness minus mill tolerance).

$$T=0.875T_{nom} \qquad \text{(M-2)}$$

Step 7

Calculate the mean radius of the pipe using the nominal wall thickness.

$$r_2 = \frac{D - T_{nom}}{2} \qquad \text{(M-3)}$$

Step 8

The design pressure for the mitered bend is determined using the equations provided below.

a) For multiple mitered bend with θ ≤ 22.5 °, P_m is the minimum of the equations M-4 and M-5:

$$P_m = \frac{SE(T-c)}{r_2}\left(\frac{T-c}{(T-c)+0.643\tan\theta\sqrt{r_2(T-c)}}\right) \quad \text{(M-4)}$$

$$P_m = \frac{SE(T-c)}{r_2}\left(\frac{R_1-r_2}{R_1-0.5r_2}\right) \quad \text{(M-5)}$$

b) For single mitered bends with θ ≤ 22.5 °, use equation M-4. Otherwise, P_m is given by equation M-6.

$$P_m = \frac{SE(T-c)}{r_2}\left(\frac{T-c}{(T-c)+1.25\tan\theta\sqrt{r_2(T-c)}}\right) \quad \text{(M-6)}$$

Step 9

The miter pipe wall thickness (T) shall extend not less than a distance (M) from the insides crotch of the end miter welds. See B31.3 Figure 304.2.3. The length of the taper at the end of the miter pipe may be included in the distance (M). The required value of (M) is the larger of M-7 and M-8.

$$M = 2.5(r_2T)^{0.5} \quad \text{(M-7)}$$

$$M = \tan\theta\,(R_1 - r_2) \quad \text{(M-8)}$$

APPENDIX N – BRANCH CONNECTIONS

The equations provided below may be used to determine the reinforcement requirements for a set-on branch connection using the methods prescribed by ASME B31.3 paragraph 304.3.3. The acceptable details that can be used with these equations are shown in figures 328.5.4D(1), (3), and (5). The equations below are based on no reinforcement pad at the branch connections. The equations are used to determine the requirements for additional reinforcement. The designer performing these calculations should review the B31.3 Code to ensure he understands all the required details. These equations are only applicable when the branch opening in the header pipe is a projection of the branch pipe inside diameter (i.e. the branch pipe is set on the header pipe).

NOTE: A Mathcad shell for calculations of reinforcement requirements for weld branch connections is available from the ESM Mechanical POC.

Step 1

Determine the total mechanical allowance (c) including the erosion and corrosion for the system in inches and the design pressure in psi.

Step 2

Determine the material allowable stress (S) at the design temperature from Appendix A, B31.3 in psi.

Step 3

Determine the joint quality factors (E_h and E_b) for the header and branch pipes from Appendix A, B31.3. For seamless pipe, E=1.

Step 4

Determine the outer diameter (D_h and D_b) and nominal wall thickness ($T_{nom,h}$ and $T_{nom,b}$) of the header and branch pipe.

Step 5

Determine the smaller angle (β) between the branch and the header. See Figure 304.3.3 of B31.3.

Step 6

Calculate the required pressure design wall thicknesses using the equations N-1 and N-2.

$$t_h = \frac{PD_h}{2(SE + 0.4P)} \tag{N-1}$$

$$t_b = \frac{PD_b}{2(SE + 0.4P)} \tag{N-2}$$

Step 7

Calculate the required reinforcement area (A_1)

$$A_1 = t_h d_1 (2 - \sin\beta) \tag{N-3}$$

where

$$d_1 = [D_b - 2(T_b - c)] / \sin\beta \tag{N-4}$$

$$T_b = 0.875 T_{nom,b} \tag{N-5}$$

Step 8

Calculate the available reinforcement area (A_2) and (A_3)

$$A_2=(2d_2-d_1)(T_h-t_h-c) \quad \text{(N-6)}$$

$$A_3=2L_4(T_b-t_b-c)/\sin\beta \quad \text{(N-7)}$$

where

$$d_2=\max[d_1,(T_b-c)+(T_h-c)+d_1/2] \quad \text{(N-8)}$$

$$T_h=0.875T_{nom,h} \quad \text{(N-9)}$$

$$L_4=\min[2.5(T_h-c), 2.5(T_b-c)] \quad \text{(N-10)}$$

Step 9

Calculate the available reinforcement area (A_4). Area A_4 is the area of other metal provided by welds and properly attached reinforcement. See B31.3 paragraph 328.5.4 for minimum required weld sizes.

Step 10

Calculate the required reinforcement area (A_r). If A_r is positive, additional reinforcement is required. If A_r is less than or equal to zero, no additional reinforcement is required.

$$A_r= A_1 - (A_2 + A_3 + A_4) \quad \text{(N-11)}$$

APPENDIX O - SAFETY CLASS PIPING SYSTEMS

PURPOSE

This appendix provides guidance for application of Code requirements to safety class items.

SCOPE

The information in this appendix applies to all piping and components designated as safety class.

GENERAL

1) New Safety Class (SC) piping shall comply with all the requirements of ASME B31.3 Category M Fluid Service unless restricted by other fluid service requirements.
2) Modifications and repairs to Safety Class piping shall comply with all the examination and testing requirements of ASME B31.3 Category M Fluid Service unless restricted by other fluid service requirements, except as permitted in Appendix P.
3) A sensitive leak test is not required for Safety Class systems unless the fluid service meets the requirements for a Category M Fluid Service or when imposed by the requirements of the Alternative Leak Test per B31.3 paragraph 345.1c.
4) When a facility has performed component level classification of piping systems only the specific components and portion of the system classified as Safety Class are required to meet the Category M requirements.

MATERIAL REQUIREMENTS

1) For safety class items, material traceability shall be maintained to the point of installation.

APPENDIX P – REPAIRS, MODIFICATIONS AND MAINTENANCE

PURPOSE

This appendix provides guidance for application of B31.3 requirements to repairs, modifications and maintenance of operating piping systems.

SCOPE

The information in this appendix applies to all piping systems for which ASME B31.3 applies.

GENERAL

Repairs and modifications to existing piping systems shall follow the requirements of the ASME B31.3 Code for materials, design, fabrication and examination. At the Design Authority's option, the three alternatives of Section A, B, or C below are acceptable to address the leak testing of repair and tie-in joints. All repair and modification joints other than the tie-in joints shall meet all the requirements of the Code. Non-welding maintenance shall follow the requirements of the ASME B31.3 Code for materials, design and fabrication. The examination and leak testing requirements for non-welding maintenance shall be as specified by the Design Authority.

Table 1 Requirement Matrix[1]

	Modification	Repair	Non-Welding Maintenance
Design	B31.3	B31.3	B31.3
Materials	B31.3	B31.3	B31.3
Fabrication[2]	B31.3	B31.3	B31.3
Examination	B31.3	B31.3	Design Authority[3]
Leak Testing	B31.3	B31.3[5]	Design Authority[4]

Notes:

1) This Table applies to all functional classifications (SC, SS, ML-1, ML-2, ML-3, etc.)
2) Fabrication refers to all shop or field fabrication, erection, assembly or disassembly related to new installations, modifications, repairs, or non-welding maintenance.
3) Unless restricted by other site or divisional requirements, the Design Authority is to determine the type and extent of examination. Performance of examinations shall be in accordance with site QA requirements.
4) Unless restricted by other site or divisional requirements, the Design Authority is to determine the type and extent of leak testing, if any, commensurate with the risk (likelihood and consequence) of leakage.
5) Also refer to sections A through C.

A REPAIR AND TIE-IN JOINTS THAT ARE CODE LEAK TESTED

Repair joints and tie-in joints in piping systems that are leak tested to the requirements of ASME B31.3 paragraph 345 “Testing” shall meet the following requirements.

1) Repair and tie-in joints shall be examined to the requirements of the Code.

413 When the repair joints and tie-in joints are not included in the random selection of joints to be examined, they shall be treated as a new and separate lot or lots of joints for examination purposes. Examination percentages of other joints (i.e. shop welds) included in the piping system repair or alteration may not be used to reduce the examination requirements of repair or tie-in joints.

B REPAIR JOINTS AND TIE-IN JOINTS THAT ARE IN-SERVICE LEAK TESTED

Repair joints and tie-in joints in piping systems that can not be Code tested but can be In- Service Leak tested to the requirements of paragraph 345.7, shall meet the following requirements. For repair and tie-in joints that can not be Code tested, the In-Service Leak Test is permitted for Normal and Category M fluid service.

1) All repair and tie-in joints shall be examined to the requirements of paragraph 335 "Assembly and Erection".

414 All butt-welded repair and tie-in joints shall be volumetrically examined to the requirements of ASME B31.3. All butt weld repair and tie-in joints shall be designed so they can be volumetrically examined, except as provided in 5.4.3.3. Welded branch connections used as tie-in joints shall meet the requirements of Figure 328.5.4E as being suitable for 100% radiography. For a normal fluid service the in-process examination alternative permitted in paragraph 341.4.1(b)(1) may be specified on a weld for weld basis if approved by engineering or the inspector. The in-process method shall be supplemented by appropriate nondestructive examination.

415 Socket welded joints are allowed as repair and tie-in welds on sizes up to and including 2 inch pipe. Slip-on flanges are allowed in all pipe sizes. All socket and slip-on repair and tie-in joints shall receive a PT or MT examination of the final completed welds.

416 An in-service leak test shall be performed on repair and tie-in joints per the requirements of ASME B31.3 paragraphs 345.7.1 - 345.7.3 except as noted in C below.

C REPAIR AND TIE-IN JOINTS THAT CAN NOT BE TESTED

Repair and tie-in joints in piping systems that can be neither Code nor In-Service leak tested

shall meet the following requirements.

1) Repair and tie-in joints shall be full-penetration butt welds between straight sections of piping of equal diameter and thickness, axially aligned, and of equivalent materials.

417 Repair and tie-in joints shall be volumetrically examined to the requirements of ASME B31.3.

418 When mechanical joints are required to be used for maintenance and tie-in joints and cannot be leak tested, these joints shall be examined to the requirements of paragraph 335 "Assembly and Erection".

APPENDIX Q - APPLICATION OF ASME B31.3 TO RADIOACTIVE FLUIDS

The processing of radioactive fluids is performed in many facilities at LANL. No section of the B31 Code of Pressure Piping addresses radioactive fluids. When starting to address what code is applicable to radioactive fluids, many engineers return to the *ASME Boiler and Pressure Vessel Code, Section III, Rules for the Construction of Nuclear Power Plant Components*. The scope of Section III is directly applicable to nuclear power systems and does not apply to processing facilities. To address the application of radioactive fluids more directly, an inquiry was sent to the ASME B31 Committee. Interpretation 12-20 clarifying the use of radioactive fluids in processing facilities is provided below:

> Question: In accordance with ASME B31.3-1993 Edition, may the owner apply B31.3 to piping containing radioactive fluids in a chemical plant?
>
> Reply: Yes, see the Introduction which states that, "If no section of the code for pressure piping specifically covers the installation, the owner at his discretion may select any section determined to be generally applicable... It should be noted, however, that requirements supplementing the Code Section may be necessary to provide safe piping for the intended application".

Interpretation 12-20 stresses the need for requirements supplementing the Code for radioactive fluid services.

Based on Interpretation 12-20, two issues need to be addressed to apply ASME B31.3 to a radioactive fluid service. First, when will a fluid service be considered radioactive. Second, what are reasonable supplementary requirements to apply. The following definition and requirements are provided to support the use of ASME B31.3 for radioactive fluid processing. The owner and/or the designer may specify additional requirements that are deemed necessary to provide a safe piping system design.

The following definition of a radioactive fluid applies to activities addressed by this guide:

Radioactive Fluid – A fluid with sufficient radioactivity that leakage from a piping system could cause an area to exceed the contamination limits imposed by P121, Att A, Table 14-2.

The following minimum additional requirement should be applied to systems containing radioactive fluids:

1) Radioactive fluids cannot be excluded from the scope of ASME B31.3.
2) Radioactive fluids cannot be classified as Category D fluid service.

Additional requirements supplementing the B31.3 Code may be required to ensure a safe design for radioactive fluid services.

APPENDIX R – DEFINITION OF ACRONYMS

AISC	American Institute of Steel Construction
API	American Petroleum Institute
ASME	American Society of Mechanical Engineering
AWS	American Welding Society
AWWA	American Water Works Association
B&PV	Boiler and Pressure Vessel
CLSM	Controlled Low Strength Material (flowable fill)
CMTR	Certified Mill Test Report
CPVC	Chlorinated Polyvinyl chloride
DOE	Department of Energy
DR	Design Ratio
EJMA	Expansion Joint Manufacturers Association
EPDM	Ethylene-propylene-diene monomer
ESM	LANL Engineering Standards Manual
IBC	International Building Code
IGSCC	Intergranular Stress-corrosion Cracking
IRHD	International Rubber Hardness Degree
LANL	Los Alamos National Laboratory
MSS	Manufacturers Standardization Society
NFPA	National Fire Protection Association
NMED	New Mexico Environment Department
NPH	Natural Hazard Phenomena
NPS	Nominal Pipe Size
OD	Outer Diameter
PE	Polyethylene
POC	Point-of-Contact
P-Spec or PS	Piping Specification
PTC	Performance Test Code
PTFE	Polytetraflouroethylene
PVC	Polyvinyl chloride
RTFE	Reinforced Polytetraflouroethylene
SCC	See IGSCC
SDR	Standard Design Ratio
SRSS	Square root sum of squares modal combination method
UHMWPE	Ultra-High Molecular Weight Polyethylene