RECORD OF REVISIONS

Rev	DATE	Description	POC	RM
0	03/03/2016	Initial issue.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
1	9/22/2023	Update to introductory section to clarify application of NASME for B31.9 systems. Added record of revisions. Updated Section and Attachment name (formerly known as Section NASME - New Non-ASME System Requirements, Attachment NASME-2- B31.9 Equivalent Safety Evaluation) for revised ESM Ch. 17 format.	Ari Ben Swartz, *ES-FE*	Dan Tepley, *ES-DO*

Contact the Standards point of contact (POC) for upkeep, interpretation, and variance issues.

Chapter 17	**Pressure Safety POC**

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

1.0 PURPOSE

This document provides code equivalencies for ASME B31.9 design basis pressure systems for use at LANL. Any of the equivalencies can be applied to a pressure system to provide an approved equivalency to that specific paragraph of B31.9 without applying all the equivalencies. Code paragraphs can be used as written. Any paragraph not listed in the equivalency table shall be used as written. The equivalencies apply to portions of pressures systems that are not ASME BPVC equipment (e.g., boilers, pressure vessels, and air receivers) or supporting piping. The equivalencies cannot contradict or invalidate facility specific safety basis requirements for credited pressure systems.

2.0 EQUIVALENCY EVALUATION

The risk-based engineering evaluation process used in this attachment is provided in Section 3.0 at the end of this attachment. The Qualitative Risk of the equivalencies provided is 4 or greater (i.e., low).

B31.9 Paragraph	**Equivalency Safety Evaluation**
Chapter I Scope and Definitions	
900.1 Scope	This equivalency may be used for all fluids within the scope of B31.9 *except steam, steam condensate, and boiler external piping*.
900.2 Terms and Definitions	In addition to 900.2 the following definitions also apply: Fully engaged: A bolt or stud shall at least be flush with exit of the nut or fastener. Listed: For the purposes of this equivalency, describes a material or component that conforms to a specification in at least one of the following: ASME B31.9 Table 926.1, Table I-1, Table I-2, Table I-3, Table I-4, or Table II-1, and ASME B31.1 Table 126.1-1 and Tables A-1 through A-10.
Chapter II Design	
PART 1 CONDITIONS AND CRITERIA	
901 DESIGN CONDITIONS	
901.1 General 901.2 Pressure 901.3 Temperature 901.4 Ambient Influences	Pressure safety officer (PSO) Duty Area C may assist and concur with designer and may serve as a designer. Designer is also known as the Engineer in this code.
901.5 Dynamic Effects	Seismic supports shall accommodate thermal expansion and contraction.
901.6 Thermal Expansion and Contraction Loads	Supports that are not fixed anchors (hangers) shall be used to accommodate thermal expansion or contraction.
902 DESIGN CRITERIA	

902.2.1 Components Having Specific Ratings	Listed components shall be the first design preference. Items listed in ASME B31.1 may also be used. Previously evaluated and approved B31.9 unlisted components are located in the Allowed Unlisted Components Microsoft Excel file. Unlisted components not on the list described above may be used if they are listed on the ESM Ch. 17 Reputable Manufacturers List. This list will be maintained on the ESM Ch. 17 website. *NOTE: Institutional Evaluation Suppliers List (IESL) is not necessarily a listing of reputable manufacturers.* Listing on a reputable manufacturer's list requires ratings that are acceptable for the design conditions of temperature, pressure, and material compatibility. or Engineering calculations showing a factor of safety of 4:1 (this item would then be entered onto the reputable manufacturer's list as well). Items being placed on this list need final approval by the chief pressure safety officer CPSO or designee. Commercial Grade Designation (CGD) qualifies ML-3 & 4 equipment from non-IESL suppliers for use in ML-1 & 2 service but does not qualify equipment for ASME B31.9 code equivalency to code concerns.
902.3 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 personal protective equipment (PPE) with PSO review and approval.
PART 2 PRESSURE DESIGN OF PIPING COMPONENTS	
904 PRESSURE DESIGN OF COMPONENTS	
904.7.2 Unlisted Components	See 902.2.1.
PART 3 SELECTION AND LIMITATION OF COMPONENTS	
907.1.2 Unlisted Valves.	See 902.2.1.
907.2 Marking	For reputable manufactured item the manufacturer's identification is acceptable.
PART 4 SELECTION AND LIMITATION OF JOINTS	
912 FLANGED JOINTS	U Vacuum style flanges for example "ConFlat" CF or KF (QF) flanges may be used after qualification in accordance with this document.
913 MECHANICAL AND PROPRIETARY JOINTS	See 902.2.1.
917 BRAZED AND SOLDERED JOINTS	Soldering shall be in accordance with B31.9. Brazing shall be in accordance with Engineering Standards Manual (ESM) Chapter 13.

PART 5 EXPANSION, FLEXIBILITY, AND SUPPORT	
919 EXPANSION AND FLEXIBILITY	Follow ESM Ch. 17 PS REQUIREMENTS "Flexibility Analysis."
920 LOADS ON PIPE-SUPPORTING ELEMENTS	Piping is not to be used to support external equipment that is not part of the piping system. Paragraph is required to be evaluated and discounted or applied. Piping supports may be in accordance with edited LANL Master Spec Section 22 0529 for all Normal Fluid Service including pressures above 150 psig. Hangers used at elbows are to be of the supporting guide style not fixed rigid style; the piping supports must allow expansion and contraction of the piping system when required by 919 above. If additional support is required, see 921.
921 DESIGN OF PIPE-SUPPORTING ELEMENTS	Use paragraph and subparagraphs except add the allowance from ASME B31.3 paragraph 321.1.2, "In general, the location and design of pipe supporting elements may be based on simple calculations and engineering judgment."
PART 6 SYSTEMS	
922 DESIGN REQUIREMENTS PERTAINING TO SPECIFIC PIPING SYSTEMS	
922.1 Pressure Reducing Systems 922.1.1	Use as is. *NOTE: Unlike ASME B31.3 there is no allowed accumulation over pressure of 10% above design pressure. For example, compressed gas systems are limited to 150 psig and B31.9 does not permit any overpressure beyond 150 psig. Therefore, if (again for example) using a "UV" stamped pressure relief valve that guarantees full capacity flow at 10% overpressure, the setpoint of the relief valve shall be set no higher than [Design Pressure – 0.10*(Design Pressure)].*
922.1.2 Alternative Systems	Do not apply paragraph 922.1.2, because this equivalency cannot be applied to steam systems (see 900.1 above).
922.3 Fuel Oil Piping	Use most applicable National Fire Protection Association (NFPA) code for combustible or flammable liquids (likely NFPA 58).
Chapter III Materials	
923 MATERIALS — GENERAL REQUIREMENTS	
923.1.2 Materials Not Listed	Use as is and reference Table 902.3.

Chapter IV Component Requirements and Standard Practices	
926 DIMENSIONS AND RATINGS OF COMPONENTS	
926.1 Standard Piping Components	Use Table 926.1 in accordance with 902.2.1 in this equivalency evaluation. Items listed in ASME B31.1 may also be used.
926.2 Standard Practices	Use as is. Other installation practices of approved unlisted components shall follow the manufacturer's instructions, for example Swagelok® or LOKRING™.
Chapter V Fabrication, Assembly, and Erection	
927 WELDED FABRICATION OF METALS	
927.1 General	Welding shall be performed in accordance with the qualification requirements of ESM Chapter 13. Limitations on imperfections and acceptance standards are as stated in B31.9 Chapter VI or in the engineering design.
927.2 Materials	Materials shall be in accordance with ESM Chapter 13.
927.3 Preparation	Preparations shall be in accordance with ESM Chapter 13.
927.4 Rules for Welding	Use as is. Welding and Brazing shall be in accordance with ESM Chapter 13.
927.5 Qualification	Qualification shall be in accordance with ESM Chapter 13.
927.6 Qualification Requirements	Qualification Requirements shall be in accordance with ESM Chapter 13.
928 BRAZING AND SOLDERING OF METALS	
928.1 Brazing	Brazing shall be in accordance with ESM Chapter 13.
929 BENDING	
929.1 General	Pipe may be bent to any radius by any hot or cold method that results in a crack free bend surface free of cracks and free of buckles. Cracks and creases in bends are not allowed. Such bends shall meet the design requirements of para. 904.2.1. This shall not prohibit the use of corrugated bends if specified in the engineering design.
Chapter VI Inspection, Examination, and Testing	
936 INSPECTION AND EXAMINATION	Use as is. Qualified PSO Duty Area C may perform the role as Owner's Inspector delegate if appointed by the Owner's Inspector.

3.0 RISK-BASED ENGINEERING EVALUATION PROCESS

This Risk-Based Evaluation process is used in Section 2.0 above and may be used in other situations (e.g., ASME, NASME) where allowed by those sections or with a variance (Form 2137). This process is based on the methodology described in API Recommended Practice 580, *Risk-Based Inspection*.

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 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.

   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 the following:

   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 1-4).

3. The Qualitative Risk based evaluation shall be based on probability and consequence of a single-point system failure for each deficiency observed.

Table 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 1-2, Failure Probability.
2. Based on the results of the consequence evaluation, a consequence bin is selected as defined in Table 1-3, Consequence of Failure.
3. Enter Table 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).

All ASME B31.9 code equivalencies in this document shall have a QR number of 4 or higher.

Table 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 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 1-4 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