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 change based on ASME interpretation. Updates for B31.3-2014.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
2	11/09/18	A342 changed to use B31.3 paragraph as written; other minor clarifications and corrections.	Ari Ben Swartz, *ES-EPD*	Larry Goen, *ES-DO*
3	9/22/23	Update to introductory section to clarify application of NASME for B31.3 systems. Combined Normal and Category D evaluations (formerly NASME-1-C and 1-D) into a single document. Updated Section and Attachment name 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 B31.3 **Metallic** systems (Fluid Categories D and Normal) for use at Los Alamos National Laboratory (LANL). Any of the equivalencies can be applied to a pressure system to provide an approved equivalency to that specific paragraph of B31.3 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 Boiler and Pressure Vessel Code (BPVC) equipment (e.g., boilers, pressure vessels, and air receivers) or supporting piping. The equivalencies cannot be applied to systems with severe cyclic conditions, Category M fluid service, High Pressure fluid service, High Purity fluid service, or Elevated Temperature fluid service (temperature in the creep range). 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).

B31.3 Paragraph	Equivalency Evaluation
Chapter I Scope and Definitions	
300 General Statements (b) Responsibilities	Pressure safety officer (PSO) Duty Area B may assist and concur with designer and may serve as a designer. Qualified PSO Duty Area B may perform the role as Owner's Inspector delegate if appointed by the Owner's Inspector.
300.1.3 Exclusions	Pressure systems outside the scope of B31.3 as defined in this paragraph are unlikely to have B31.3 as part of the design basis.
300.2 Definitions	This table is **not** applicable to Category M Fluid Service, Elevated Temperature Fluid Service, High Pressure Fluid Service, or High Purity Fluid Service.

Chapter II Design	
301.1 Qualifications of the Designer	See above 300 General Statements (b) Responsibilities.
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 (50°C) (this is to ensure there is no effect from thermal linear change).
301.3.1 Design Minimum Temperature	Category Normal: Minimum design temperature is a function of the material and the lower allowable temperatures in Table A.

	Category D: 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 the ambient temperature is less than 120°F (50°C). *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 in a relatively constant temperature environment (+/- 10°F) and the temperature is less than 120°F (50°C) (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 for flex hose restraints to reduce whip hazard.
301.9 Reduced Ductility Effects	Category Normal: Paragraph is required to be evaluated and discounted or applied. Category D: Not applicable.
302.2.1 Listed Components Having Established Ratings	Listed components shall be the first design preference. Previously evaluated and approved B31.3 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 Engineering Standards Manual (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.* 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 B31.3 code equivalency to code concerns.

302.2.2 Listed Components Not Having Specific Ratings	Use reputable manufacturers' published ratings. A Reputable Manufacturers List of approved unlisted components will be maintained on the ESM Ch. 17 website.
302.2.3 Unlisted Components	Use reputable manufacturers' published ratings. A Reputable Manufacturers List of approved unlisted components will be maintained on the ESM Ch. 17 website.
302.3 Allowable Stresses and Other Stress Limits	The designer 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).
302.3.5 Limits of Calculated Stresses Due to Sustained Loads and Displacement Strains	The 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 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	Applies only when occasional loads are a factor in piping system integrity (e.g., seismic or wind loads apply).
302.4 Allowances	Fluid shall be evaluated and determined to be compatible for the service life of the system with the materials of construction and manufacturer's recommendations. Otherwise, allowances shall be added in accordance with the paragraph.
304 Pressure Design of Components 304.1 Straight Pipe	All LANL component designs or custom component designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
304.2 Curved and Mitered Segments of Pipe	All LANL component designs or custom component designs for LANL 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 manufacturers' 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	All LANL component designs or custom component designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
304.4 Closures	All LANL component designs or custom component designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
304.5 Pressure Design of Flanges and Blanks	All LANL component designs or custom component designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
304.6 Reducers	All LANL component designs or custom component designs for LANL 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 manufacturers' 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 four 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 four times the design pressure (MAWP) maximum allowable working pressure. 2) Determine if the piping component was previously used in accordance with paragraph 304.7.2 (a). 3) Pressure test to four times the design pressure. 4) Perform Engineering Finite Element Analysis (FEA) in accordance with paragraph 304.7.2 (d).
305 Pipe	The paragraph is required to be evaluated and discounted or applied.
306 Fittings, Bends, Miters, Laps, and Branch Connections	All LANL designs or custom designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
307 Valves and Specialty Components	All LANL designs or custom designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
308 Flanges, Blanks, Flange Facing, and Gaskets	All LANL designs or custom designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*

309 Bolting	All LANL designs or custom designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
311 Welded Joints	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
311.2 Specific Requirements	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
311.2.1 Welds for Category D Fluid Service	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
311.2.7 Seal Welds	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
312 Flanged Joints	U Vacuum style flanges for example "ConFlat" CF or KF (QF) flanges may be used after qualification in accordance with this document.
314 Threaded Joints	All LANL designs or custom designs for LANL 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 manufacturers' published ratings this paragraph does not apply.*
315 Tubing Joints	All LANL designs or custom designs for LANL shall comply with paragraph 315. 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 manufacturers' 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	Category Normal: Not permitted for Normal Fluid Service. Category D: Permitted for Category D; use paragraph 316 as written.
317 Soldered and Brazed Joints	Soldering shall meet B31.3 para. 317.1 requirements and may only be used in Category D fluid service.

	Brazed joints shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
318 Special Joints	Evaluate in accordance with 304.7.2 in this equivalency evaluation. *NOTE: The use of "gland" in this paragraph does not mean Swagelok gland fitting.*
319 Piping Flexibility	Follow ESM Ch. 17 REQUIREMENTS "Flexibility Analysis."
320 Analysis of Sustained Loads	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 LANL Master Specification 22 0529. 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."

Chapter III 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.
323.1.2 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 manufacturers' 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	Unknown materials shall not be used.
323.2 Temperature Limitations	Category Normal: Use B31.3 paragraph as written. Category D: 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	Identify the temperature limits of the materials.

323.2.2 Lower Temperature Limits, Listed Materials	Category Normal: Use B31.3 paragraph as written. Category D: 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 manufacturers' 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.
323.3 Impact Testing Methods and Acceptance Criteria	Category Normal: Use B31.3 paragraph as written. Category D: Not required for Category D Fluid Service.
323.4 Fluid Service Requirements for Materials (entire)	Category Normal: Use B31.3 paragraph as written. Category D: 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.

Chapter IV Standards for Piping Components	
326 Dimensions and Ratings of Components	Listed components shall be the first design preference. Previously evaluated and approved B31.3 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. Listing on a reputable manufacturers 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 3:1 (this item would then be entered onto the reputable manufacturers list as well). Items being placed on this list need final approval by the chief pressure safety officer (CPSO) or Designee. Commercial Grade Dedication (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.

Chapter V Fabrication, Assembly, and Erection	
328 Welding	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
330 Preheating	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
331 Heat Treatment	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
331.2 Specific Requirements	Welding and brazing shall be done in accordance with ESM Chapter 13 *Welding, Joining, & NDE* [Nondestructive Examination].
332 Bending or Forming	Bend or form in accordance with the manufacturer's specification or requirements.
333 Brazing and Soldering	Welding and brazing shall be done in accordance with ESM Chapter 13. Category Normal: Soldering is not permitted for Category Normal. Category D: Soldering is permitted; see para. 317.1. Follow B31.3 paragraph 333 as written.
335 Assembly and Erection	Assemble in accordance with the manufacturer's specification or requirements.

Chapter VI Inspection, Examination, and Testing	
340 Inspection 340.1 General	Qualified PSO Duty Area B may act as the Owner's Inspector. Owner's Inspector shall be knowledgeable with the pressure system of interest.
340.4 Qualifications of the Owner's Inspector	See paragraph 300. Qualified PSO Duty Area B may act as the Owner's Inspector or equivalent.
345 Testing	Pneumatic leak testing is approved for all systems with less than 1000 lb-ft stored energy during testing. Additional stored energy must be approved by the CPSO. Follow B31.3 paragraphs as written. *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.* Category Normal: The Owner accepts pneumatic or hydro-pneumatic leak testing with inert gas or air (additional testing may be required by the Designer).

	Category D: Owner has elected to use Initial Service Leak Test for Category D Fluid Service (additional testing may be required by the Designer).

3.0 RISK-BASED ENGINEERING EVALUATION PROCESS

This Risk-Based Evaluation process is used in Chapter 17 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 applied in 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 B31.3 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**
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