



# Conduct of Engineering Request for Variance or Alternate Method

To display the *VAR Request Metadata* pane for this document, click **File > Info > Properties > Show Document Panel.**

## 1.0 General

1.1 Document Number: <b>VAR-2016-013</b>		1.2 Revision: <b>1</b>									
1.3 Brief Descriptive Title: <b>Allow Use of Unlisted LokRing Fittings for ASME B31.3 and B31.9 Pressure Systems</b>											
1.4 Affected Program: <b>Engineering Standards</b>		1.5 Request Type: <b>Alternate Method</b>									
1.6a Affected Tech Area <b>99</b>		1.6b Affected Buildings <b>Sitewide</b>									
1.7 Requestor: <b>Stringfield, Randy</b> Organization: <b>PFE-WF</b>											
1.8 Revision History <table border="0"> <tr> <td>Revision Number</td> <td>Changes and Comments</td> </tr> <tr> <td><b>0</b></td> <td><b>Initial issue.</b></td> </tr> <tr> <td>Revision Number</td> <td>Changes and Comments</td> </tr> <tr> <td><b>1</b></td> <td><b>Clarified title to include B31.3. In compensatory measures, added training and inspection material. In limitations, allowed for use in nuclear safety systems (carbon and stainless pipe and tube fittings). Updated material on brass fittings in Appendices. Corrected the B31.3 calculation typo (now divisor of 3)</b></td> </tr> </table>				Revision Number	Changes and Comments	<b>0</b>	<b>Initial issue.</b>	Revision Number	Changes and Comments	<b>1</b>	<b>Clarified title to include B31.3. In compensatory measures, added training and inspection material. In limitations, allowed for use in nuclear safety systems (carbon and stainless pipe and tube fittings). Updated material on brass fittings in Appendices. Corrected the B31.3 calculation typo (now divisor of 3)</b>
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## 2.0 Affected Conduct of Engineering Program/Documents

2.1 Affected "P" Document: <b>P342 Engineering Standards</b>  If against the P document itself, revision (or <b>N/A</b> ): <b>N/A</b>	2.2 Subordinate or related document(s) [AP, master spec, LANL ESM chapter & section; or code, Order, standard, etc.]: Document Title/No.: <b>ESM Chapter 17, Pressure Safety, Section GEN</b>  Revision <b>0.1</b> Document Title/No.: <b>Section ADMIN-2, Design, Documentation, and Records</b>  Revision <b>0</b> Document Title/No.: <i>Enter text..</i>  Revision <i>Enter text..</i>
2.3 Section/Paragraph: <b>see 2.4 below</b>	
2.4 Specific Requirement(s) as Written in the Document(s): <b>Section GEN- <i>General Requirements</i>, Subsection 1.0, Paragraph A, <i>Introduction and Applicability</i>, Para 5:</b>  "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 B31.3 code.

- a. For example, use B31.1 for site steam distribution, B 31.5 for refrigeration piping, and B31.9 for building services where the LANL-adopted plumbing code does not apply."

Section ADMIN-2, *Design and Documentation*, Article Z., *Unlisted, Specialty, or Unique Components*, Paragraph 1:

"Unlisted components allowed for new construction must demonstrate equal or greater level of safety at the pressure and temperature of the system. ASME B31.3 requires a safety factor of 3:1, **ASME B31.1 requires a safety factor of 4:1**. For existing systems, refer to Section EXIST."

Section ADMIN-2, *Design and Documentation*, Rev. 0, Article Z, *Unlisted, Specialty, or Unique Components*, Paragraph 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."

2.5 Contractual, preference, or other basis for requirement in 2.4:

LANL implementation method for Owner concurrence on unlisted components satisfying code, which is a contractual obligation.

2.6 Type of VAR from ESM Chap 1, Z10 [*Applies only to standards variances*])

Type 2

2.7 Discipline

Pressure Safety

### 3.0 Request Information & Comments

3.1 NCR required (work has occurred)? **No**

If Yes, NCR Number: [Enter text.](#)

3.2 System/Component Affected

OpSystem Acronym & Name [[Select OpSysAcronymAndName](#)]

System Number or Name [[Select SystemNumberOrName](#)]

3.3 Highest ML Level

ML-1

3.4 Proposal with Justification/Compensatory Measures:

Allow LokRing™ to be used for both B31.3 *Process Piping* and B31.9, *Building Services Piping*.

#### **Justification**

The most applicable code for construction and the current code of record for facility or building services is ASME B31.9-2020, *Building Services Piping*. The term '*unlisted components*' is used if a component is not listed in the ASME B31.9 component standard Table, 926.1 or Mandatory Appendix I. The code gives methods to evaluate and utilize unlisted

items. The following is an evaluation showing that LokRing™ is accepted for use for ASME B31.9-2014 but logically also holds for B31.9-2020 and ASME B31.3-2020.

The ASME B31.9-2014 allows B31.1 listed components and materials as it states:

902.3.1 Allowable Stress Values, Allowable stresses for materials not listed in Mandatory Appendix I shall be as listed in ASME B31.1 or shall be determined using the bases in paras. 902.3.1(b) through (f), as applicable.

923.1.2 Materials Not Listed. Allowable stresses for materials not shown in Mandatory Appendix I, but which are shown in ASME B31.1, may be taken from Mandatory Appendix A of ASME B31.1.

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.

As explained in the ASME Continuing Education Institute's In-Company Training: Course Title "ASME B31.3 Process Piping", Course Number PD014; Course Handout Title "ASME B31.3 Process Piping Design" by Glynn Woods, P.E. page 17:

"B31.3 uses a 3:1, where B31.1 uses a 4:1 factor of safety."

Therefore, a factor of safety of 4:1 may also be used for B31.9 pressure systems, and a 3:1 may be used for B31.3 pressure systems.

The Engineering Designer is allowed to exercise engineering judgement.

#### B31.9-2014

Introduction page viii

"The Code sets forth engineering requirements deemed necessary for safe design and construction of pressure piping. While safety is the basic consideration, this factor alone will not necessarily govern the final specifications for any piping system. The designer is cautioned that the Code is not a design handbook; it does not do away with the need for the designer or for competent engineering judgment."

#### 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."

#### B31.3-2014

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The Code sets forth engineering requirements deemed necessary for safe design and construction of pressure piping. While safety is the basic consideration, this factor alone will not necessarily govern the final specifications for any piping installation. The Code is not a design handbook. The requirements of this Code generally employ a simplified approach. Many decisions that must be made to produce a sound piping installation are not described in detail by this Code. The Code does not eliminate the need for sound engineering judgments by the owner and the designer.

### 300 General Statements (c) (3)

(3) The Code generally employs a simplified approach for many of its requirements. A designer capable of applying a more complete and rigorous analysis consistent with the design criteria of this Code shall have the latitude of applying such analysis in the development of designs and fabrications. The designer shall provide details of design, construction, examination, and testing, along with calculations consistent with the design criteria of this Code. The details shall be documented in the engineering design and their validity accepted by the owner.

Since the safety factor for ASME B31.1 is 4:1 and B31.1 listed items may be utilized by B31.9, if we demonstrate a simple 4:1 factor of safety then LokRing™ fittings may be safely applied to the B31.9 systems.

The same principle applies to the ASME B31.3 application; if we demonstrate a simple 3:1 factor of safety, along with the required details of the design, construction, examination, and testing, then LokRing™ fittings may be safely applied to the B31.3 systems.

Example Calculation:

#### B31.9

LokRing™ Pressure rating of Carbon Steel Pipe Produce (Size P16) for 1 NPS inch Schedule 40 pipe for B31.1 service is 3030 psig

Safety Factor: 4

Allowable Pressure Rating:  $3030/4 = 758$  psig

#### B31.3

LokRing™ Pressure rating of Carbon Steel Pipe Produce (Size P16) for 1 NPS inch Schedule 40 pipe for B31.3 service is 4050 psig

Safety Factor: 3

Allowable Pressure Rating:  $3030/3 = 1350$  psig

The tables of LANL LokRing™ pressure ratings for carbon steel pipe fittings, stainless steel pipe fittings, stainless steel tube fittings, and brass tube fittings are in **Appendix 1** for B31.9 and **Appendix 2** for B31.3.

The LokRing™ documentation used for the basis of the calculation are contained in **Appendix 3**.

### **Compensatory Measures and Limitations**

Additional details of design, construction, examination, and testing (required for B31.3 evaluation but apply to both B31.9 and B31.3 applications).

A Pressure Safety Officer and Owner's Inspector shall review the application of LokRing™ to ensure:

- 1) Fittings are selected correctly
- 2) The base material is identified and is amenable to the joining system
- 3) The pipe or tubing is correct for the application
- 4) The minimum required pipe or tubing wall thickness for the application is calculated
- 5) The installation is by trained and qualified personnel in accordance with UTrain Lokring™ Compression Systems (Course 57198) and Lokring™ Installer Certification (Course 53986)
- 6) Examination and Inspection is by trained and qualified personnel (see ESM Chapter 13, *Welding, Joining & NDE*, for ITM-1306-NDE-VT-101, *Visual and Dimensional Examination*, and the listing of Inspectors currently under the heading of "Quick Links" as "Welder Qualification Database")
- 7) The minimum wall thickness of the joint is determined and verified prior to joining (**minimum thickness includes thicknesses required for pressure stress and static or dynamic [occasional] stresses**)
- 8) The pipe or tubing hardness is less than or equal to the maximum allowed by the Lokring prior to joining.
- 9) Working pressures are adjusted for temperature using the appropriate derating factor.
- 10) Dissimilar joints shall be rated at the lower pressure rating. Dissimilar joints shall be joined only with the higher rated material, for example a stainless steel tube fitting would be used to join copper and stainless tube and the joint would be rated as the listed for the brass rating.

Specific requirements for each fitting type are show below:

LokRing™ carbon steel and stainless steel **pipe** fittings are subject to the following limitations (as applicable for B31.3 or B31.9)

- 1) Temperature rating of the fittings is limited to 300 °F for stainless steel fittings and 400 °F for carbon steel fittings.
- 2) May not be utilized in ASME B31.3 Category M fluid Systems
- 3) May not be utilized in ASME B31.3 Severe Cyclic Applications
- 4) May not be utilized in ASME B31.3 High Pressure Applications
- 5) May not be utilized in ASME B31.3 High Purity Applications
- 6) May not be utilized in systems that are "Supporting piping systems" for pressure vessels, boilers, and air receivers.
- 7) May not be utilized as the interface joint between the piping and an ASME Section VIII pressure vessel or boiler
- 8) May not be utilized in applications susceptible to crevice corrosion or chloride stress cracking
- 9) May not be utilized in radioactive services without a review by the Cognizant System Engineer or PSO if no CSE.
- 10) Thickness of shell, pipe wall thickness, after polishing must be verified to be greater than or equal to the required wall thickness as defined by B31.3 paragraph 304.1 prior to installation of fitting
- 11) Hardness of existing pipe (using a representative sample from the existing pipe) shall be verified by testing to be less than or equal to the LokRing™ specification (Rockwell B 90) prior to installation of fitting. Hardness of new piping shall be verified by manufacturer supplied data or verified by testing to be less than or equal to the LokRing™ specification (Rockwell B 90) prior to installation of fitting
- 12) Installation must be performed by LokRing™ trained and certified personnel
- 13) Application of sealant to the fitting must be approved by the Cognizant System Engineer or PSO if no CSE.
- 14) Read and apply the manufacturer's requirements in their published documents for example Lockring™ Fitting Applications Guide (PN 6090127 2014)

LokRing™ brass fittings are subject to the following limitations (as applicable for B31.3 or B31.9)

- 1) Use is limited to ASTM B88 K and L tube thicknesses in the drawn condition (H58 temper designation).
- 2) Temperature rating of the fittings is limited to 400 °F for brass
- 3) May not be utilized in ASME B31.3 Category M fluid Systems
- 4) May not be utilized in ASME B31.3 Severe Cyclic Applications
- 5) May not be utilized in ASME B31.3 High Pressure Applications
- 6) May not be utilized in ASME B31.3 High Purity Applications
- 7) May not be utilized in systems that are "Supporting piping systems" for pressure vessels, boilers, and air receivers.
- 8) May not be utilized as the interface joint between the piping and an ASME Section VIII pressure vessel or boiler
- 9) May not be utilized in applications susceptible to crevice corrosion or chloride stress cracking
- 10) May not be utilized in radioactive services without a review by the Cognizant System Engineer or PSO if no CSE.
- 11) Thickness of shell, tube wall thickness, after polishing must be verified to be greater than or equal to the required wall thickness as defined by B31.3 paragraph 304.1 prior to installation of fitting
- 12) Hardness of existing tube (using a representative sample from the existing tube) shall be verified by testing to be greater than or equal to the LokRing™ specification (Rockwell 30 per 30T Scale) prior to installation of fitting. Hardness of new piping shall be verified by manufacturer supplied data or verified by testing
- 13) May not be used on annealed (K, L, M) or type M (annealed or drawn) tube.
- 14) May not be installed closer than 6 inches from any brazed joint.
- 15) Installation must be performed by LokRing™ trained and certified personnel
- 16) Application of sealant to the fitting must be approved by the Cognizant System Engineer or PSO if no CSE.
- 17) Read and apply the manufacturer's requirements in their published documents for example Lockring™ Fitting Applications Guide (PN 6090127 2014)
- 18) Evaluation of copper tubing application for MAWP is in alternative method VAR-2015-011

LokRing™ stainless steel **tube** fittings are subject to the following limitations (as applicable for B31.3 or B31.9)

- 1) Temperature rating of the fittings is limited to 300 °F for stainless steel fittings.
- 2) May not be utilized in ASME B31.3 Category M fluid Systems
- 3) May not be utilized in ASME B31.3 Severe Cyclic Applications
- 4) May not be utilized in ASME B31.3 High Pressure Applications
- 5) May not be utilized in ASME B31.3 High Purity Applications
- 6) May not be utilized in systems that are "Supporting piping systems" for pressure vessels, boilers, and air receivers.
- 7) May not be utilized as the interface joint between the piping and an ASME Section VIII pressure vessel or boiler
- 8) May not be utilized in applications susceptible to crevice corrosion or chloride stress cracking
- 9) May not be utilized in radioactive services without a review by the Cognizant System Engineer or PSO if no CSE.
- 10) Thickness of shell, tube wall thickness, after polishing must be verified to be greater than or equal to the required wall thickness as defined by B31.3 paragraph 304.1 prior to installation of fitting
- 11) Hardness of existing tube (using a representative sample from the existing tube) shall be verified by testing to be less than or equal to the LokRing™ specification (Rockwell B 90) prior to installation of fitting. Hardness of new piping shall be verified by manufacturer supplied data or verified by testing to be less than or equal to the LokRing™ specification (Rockwell B 90) prior to installation of fitting
- 12) Installation must be performed by LokRing™ trained and certified personnel
- 13) Application of sealant to the fitting must be approved by the Cognizant System Engineer or PSO if no CSE.
- 14) Read and apply the manufacturer's requirements in their published documents for example Lockring™ Fitting Applications Guide (PN 6090127 2014)

#### Example Minimum Wall Thickness Calculations

Calculated wall thickness values for **B31.9** for design pressure of 150 psig

The minimum required wall thickness for pressure stress for carbon steel pipe, stainless steel pipe, stainless steel tube, and copper tubing are contained in **Appendix 4** for a maximum of 150 psig at the highest allowable temperature (400 °F for carbon steel and brass, and 300 °F for stainless steel) with no additional thickness for corrosion allowance (A = 0). In order to make these tables bounding calculations the minimum allowable stress from either ASME B31.3-2014 or B31.9 2014 were used. In addition, the lowest value of joint efficiency (E = 0.6) was used from B31.9 2014 Table 902.4.3. A sample calculation of equation (1) is shown below:

$$t_m = PD/2SE + A$$

where:

- t<sub>m</sub> = minimum thickness (for **pressure stress only**)
- S = 10,800 psi ASTM A312 TP316L (ASME B31.1 2014)
- A = Corrosion Allowance = 0
- P = 150 psig
- D = OD inches (1/2 inch tube) = 0.5 in
- E = 0.6

therefore:

$$t_m = (150 \text{ psig} * 0.5 \text{ in}) / (2 * 10,800 \text{ psi} * 0.6)$$
$$t_m = 0.0058 \text{ inch}$$

Calculated wall thickness values for **B31.3** for design pressure of 150 psig

The minimum required wall thickness for pressure stress for carbon steel pipe, stainless steel pipe, stainless steel tube, and copper tubing are contained in Appendix 4 for a maximum of 150 psig at the highest allowable temperature (400 °F for carbon steel and brass, and 300 °F for stainless steel) with no additional thickness for corrosion allowance (A = 0). To make these tables bounding calculations the minimum allowable stress from either ASME B31.1-2014 or B31.9 2014 were used. In addition, the lowest value of joint efficiency (E = 0.6) was used from B31.9-2014 Table 902.4.3. A sample calculation of equation (1) is shown below:

$$t_m = PD/[2(SEW + PY)]$$

where:

- $t_m$  = minimum thickness (for **pressure stress only**)
- $S$  = 16,700 psi ASTM A312 TP316L (ASME B31.3 2014)
- $A$  = Corrosion Allowance = 0
- $P$  = 150 psig
- $D$  = OD inches (1/2 inch tube) = 0.5 in
- $E$  = quality factor from Table A-1A or A-1B = 1.0
- $W$  = weld joint strength factor 302.3.5(e) = 1
- $Y$  = Table 304.1.1 coefficient = 0.4

therefore:

$$t_m = (150 \text{ psig} * 0.5 \text{ in}) / [2 * (16,700 \text{ psi} + 150 \text{ psig} * 0.6)]$$
$$t_m = 0.0022 \text{ inch}$$

### **Summary:**

With a factor-of-four reduced working pressure of the LokRing™ fittings for B31.9 and three for B31.3, the conservative values used in the bounding minimum wall thickness calculation, and the controls established to ensure a quality assembly this alternative method the risk is low ranked 5 as a product of a frequency of E "Improbable" and a consequence of IV "Minor- First aid injuries only, and/or minimal environmental impact" from ESM Chapter 17, Attachment EXIST-1, *Risk-Based Engineering Evaluation Process*.

### **Appendices Attached to this Form:**

- 1) Appendix 1: LANL LokRing™ Pressure Ratings for B31.9 Service (carbon steel pipe fittings, stainless steel pipe fittings, stainless steel tube fittings, brass tube fittings)
- 2) Appendix 2: LANL LokRing™ Pressure Ratings for B31.3 Service (carbon steel pipe fittings, stainless steel pipe fittings, stainless steel tube fittings, brass tube fittings)
- 3) Appendix 3: LokRing™ Publications
  - a. Pipe Solutions, Rev. 8 (Carbon Steel and Stainless Steel 28 pages)
  - b. Tube Solutions, Rev. 6 (Stainless Steel 24 pages)
  - c. Medical Gas Solutions, Rev. 4 (Brass 8 pages)
- 4) Appendix 4: Minimum Wall Thickness by Material and Size (for 150 psig) (B31.9 and B31.3)
  - a. Carbon Steel Pipe
  - b. Stainless Steel Pipe
  - c. Stainless Steel Tube
  - d. Copper Tube

### 3.5 Attachments

Document Title or Description [see Appendices above](#)

3.6a Project ID

N/A

3.6b: Project Name

N/A

3.6c: Code of Record Date

N/A

3.7 Duration:

[Lifetime](#)

3.8a If Finite Period, Start Date:

[Click to enter a date.](#)

3.8b End Date:

[Click to enter a date](#)

3.8c Provide the PFITS number for tracking removal/correction: [\[PFITSNum\]](#)

3.9 USQD/USID required (Nuclear, High/Mod Hazard)? **No**

If Yes, USQD/USID Number [Click here to enter text.](#)

3.10 QA Review for process change matters potentially affecting LANL's NQA-1 implementation

Is a QPA Determination required?: **No** If **Yes**, then: [Choose an item.](#)

QPA Comments: [Enter text..](#)

3.11 POC Determination: **Accept**

POC Comments: [Enter text..](#)

3.12 Management Program Owner's (SMPO) Approval for P341 and APs; P342, ESM, ML-1 and -2, and Contract Matters; and P343

SMPO Determination: **Accept**

Comments: [Enter text..](#)

**4.0 Participant Signatures** **NOTE:** DO NOT ADD NAMES FROM WITHIN WORD! Save and close the form first, then do 1-4 below:

1. From the SharePoint library, select the document, then click the **ellipsis (...)** in the second column; a small dialog appears
2. In the small dialog click the **ellipsis** again
3. Click **Edit Properties** and check out the document if prompted to Enter names using the controls provided, then **Save**

4.1 POC (Management Program Owner's Representative):  Swartz, Ari Ben	Organization ES-EPD	Signature
4.2 Facility Design Authority Representative  [FDARName] FDAR signature not required <input checked="" type="checkbox"/>	Organization <a href="#">Enter text..</a>	Signature
4.3 LANL Owing Manager (FOD or R&D/Program)  [FODorPrgmMgrName] FOD or Program Manager signature not required <input checked="" type="checkbox"/>	Organization <a href="#">Enter text..</a>	Signature
4.4 Quality Reviewer's Name:  [QPAName] QPA review/signature not required <input checked="" type="checkbox"/>	Organization <a href="#">Enter text.</a>	Signature
4.5 Safety or Security Management Program Owner's Approval for P341 and APs; P342, ESM and Contract Matters; and P343  Apperson, Jason Wesley SMPO signature not required (Type 1 variance) <input type="checkbox"/>	Organization ES-DO	Signature



<p>4.6 Additional Signer 1</p> <p>[AdditionalSigner1]</p> <p>Role: Enter text.</p>	<p>Organization</p> <p>Enter text.</p>	<p>Signature</p>
<p>4.7 Additional Signer 2</p> <p>[AdditionalSigner2]</p> <p>Role: Enter text.</p>	<p>Organization</p> <p>Enter text.</p>	<p>Signature</p>

<p>4.8 CoE Administrator Signature</p> <p>Salazar-Barnes, Christina L</p> <p><b>NOTE:</b> The CoE Admin is always the last signature placed on this document. The date of that signing is the date of this document.</p>	<p>Signature</p>
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9/13/2022 Added Appendices as referenced in 3.4 and 3.5.