



## Engineering Standards Manual

### Variance/Exception/Alternate Method Form

*The requesting organization completes items 1-7*

Variance to ESM

OR other Standards Program Document No.: Chapter 17

(Note, for Master Specs, Std Details, and Drafting Manual use email to/from Standards Discipline POC)

Chapter/ Title	ESM Chapter 17, <u>Pressure Safety</u> Revision 2 (8/3/09)	Section/ Page:	Section 10.0 Design and Documentation
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**1. Specific requirements as written:**

**Overview:** This Alternate Method was submitted to allow construction of LANL pressure systems with Swagelok, ASME B31.3 Unlisted Components.

**General**

1.1 This form was submitted in accordance with ESM Chapter 17, Pressure Safety, Section 2.0, Section Overview, Paragraph D

"Deviations from this chapter must be approved by the CPSO and Site Chief Engineer using the variance process found in ESM Chapter 1 Section Z10."

**ASME B31.3 Unlisted Components used for New Construction**

1.2 ESM Chapter 17, Pressure Safety, Section 10.0, Design & Documentation, Paragraph O, Piping Components paragraph 1.

"Components that meet a listed standard in ASME B31.3 must be selected for use in construction or fabrication of a piping system. 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. Other unlisted components must be evaluated based upon criteria of ASME B31.1, ASME B31.3, or ASME Section VIII."

1.3 ASME B31.3 paragraph 304.7.2 "Unlisted Components" States

**"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 29 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."**

1.4 ASME B31.3 Committee has issued the following interpretation:

Interpretation: 20-26



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Subject: ASME B31.3-2002 Edition, Para. 304.7.2

Date Issued: May 20, 2005

File: B31-05-180

Question: Does ASME B31.3-2002 Edition, para. 304.7.2, require calculations consistent with the design criteria of the Code be performed and that these calculations be substantiated by means of (a), (b), (c), or (d)?

Reply: Yes.

### 2. Variance/Exception/Alternate Method Proposed:

2.1 This Alternative Method allows continued use of Swagelok components (tubing, fittings, and valves) for construction of LANL pressure systems in accordance with ASME B31.3 304.7.2 Unlisted Components.

### 3. Justification:

#### 3.1 Publications reviewed:

1. ASMB B31.3 *Process Piping* 2008
2. ASME *Interpretations* Volume 20
3. Swagelok "Design Standards for Swagelok Products" SCS-00657 Rev. A, August 15, 2005
4. Swagelok "Valve Pressure-Temperature Ratings", MS-06-08
5. Swagelok "Tubing Data" MS-01-107 2007
6. Swagelok "Gaugeable Tube Fittings and Adapter Fittings" MS-01-140, 2007
7. Swagelok, Customer Test Report, CTR-2191 October 21, 2009 (burst testing of VCR seal fittings)
8. Swagelok, Customer Test Report, CTR-2192 October 21, 2009 (burst testing of Swagelok B series bellows-sealed valves)
9. Swagelok Letter "B31.3 Stainless Steel", 6-06-06
10. Swagelok Letter "B31.3 Stainless Steel", 6-07-06
11. Swagelok correspondence "Swagelok and ASME weld procedures", "From Paul Hardaway to George.Rawls" Jun 11, 2009
12. Swagelok Customer Test Report CTR-2148, September 22, 2009
13. Swagelok Letter to John Lennon, Arizona Valve & Fitting Co., Feb 18, 2008.
14. 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.

#### 3.1 Evaluation Methodology

- Swagelok publication MS-01-140 page 9 states "Swagelok tube fittings are rated to the working pressure of tubing as listed in the Swagelok *Tubing Data* MS-01-107".
- ASME B31.3 2008 edition equation 304.1.2 (3a), was used to evaluate Swagelok tubing and by manufacturers stated equivalency this will provide a B31.3 rating for the Swagelok fitting as well.
- Evaluation of Swagelok valves will be based on the manufacturer's stated design principles; actual valve burst test results, and the ASME Course Number PD014. It will be shown that Swagelok valves exceed the minimum factor of safety required by ASME B31.3.

#### 3.3 Generic Evaluation of Swagelok tube and tube fittings

$$t = PD / (2(SEW + PY)) \quad [\text{equation 304.1.2 (3a)}]$$

P = internal design gauge pressure  
D = outside diameter of pipe as listed in tables of standards or specifications or as measured  
E = Quality factor from Table A-1A or A-1B  
W = Weld joint strength reduction factor per para. 302.3.5(e)  
t = pressure design thickness, as calculated in accordance with para. 304.1.2 for internal pressure  
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  $t \geq D/6$ ,  $Y = (d + 2c)/(D + d + 2c)$   
S = stress value for material from Table A-1 (304, 316 tube S = 20.0 ksi Table A-1 page 164)

Swagelok stainless steel tubing is produced to ASTM A269 08. ASTM A269 08 allows wall thickness variation of 15% up to 1/2 inch and 10% 1/2 and above. For the calculation the available wall thickness was reduced by the allowed under tolerance of the ASTM A269 08.

In all cases using these criteria the Swagelok tubing and by similarity tube fittings were rated equal to or greater than ASME minimum requirements.

### 3.5 Evaluation of Swagelok Valves

Swagelok "Design Standards for Swagelok Products" SCS-00657 Rev. A, August 15, 2005, paragraph 3.0 Design Basis, subparagraph 3.1 Instrumentation Valve Standards, 3.1.2 Design states as direction for Swagelok designers;

"A finite element analysis (FEA) may also be performed in lieu of the above equation. This analysis will be performed at the minimum wall conditions and full pressure rating of the product. The maximum stress from this analysis shall be less than the maximum allowable stress with the 4:1 safety factor @ 100 °F."

Swagelok, Customer Test Report, CTR-2192 October 21, 2009 contains burst testing performed in accordance with ASME BPVC Section I, A-22 and ASME Code Section VIII, Division 1, UG-101. The burst testing was witnessed by an independent representative. In all cases the tested Swagelok valves burst at values greater than a ratio of 4:1 based rated working pressure.

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

**Swagelok valves using a 4:1 factor of safety provide increased factor of safety over B31.3 minimum requirements of 3:1 factor of safety.**

3.4 LANL has excellent service history using Swagelok components (tubing, fittings, and valves) when properly installed.

3.5 **Summary:** The ASME B31.3 calculation, 304.1.2 (3a), the increased factor of safety (4:1 > 3:1), and the extensive service history of the Swagelok components meets the criteria established under paragraph ASME B31.3 304.7.2.

### 4. Applicable compensating measures:

None



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<b>5. Duration: (specify dates or lifetime)</b>		<b>Lifetime</b>	
<b>6a. LANL Requestor/Org(Print):</b> A.B. Swartz, ES-DE	<b>6b. Title:</b> SME Pressure Systems	Signature On File	<b>6d. Date:</b> 11/2/09
<b>7a. Requesting Des Authority Rep</b> A.B. Swartz, ES-DE	<b>7b. Title:</b> SME Pressure Systems	Signature On File	<b>7d. Date:</b> 11/2/09
<p><i>For the <b>ESM</b>, the <b>Requestor</b> forwards request to the <b>ESM Discipline POC</b> for review and concurrence or denial with copy to the <b>Eng. Stds. Mgr</b> (click <a href="#">here</a> for listings). <b>For Other policies</b>, forward to <b>CENG Office Director</b>.</i></p>			
Standards Discipline POC Action			
<b>Concurrence:</b> <input checked="" type="checkbox"/> <b>Declined:</b> <input type="checkbox"/>			
PrintedName/Org <u>Charles Dupée, ES-DE</u>		Signature/date	Signature On File <u>11/2/09</u>
<b>Additional Comments:</b> (use continuation sheet if necessary)			
Final Approval			
<u>Daniel Sternberg</u> CENG Office Director or Site Chief Engineer for Issuing Authority (ADE)		Signature On File	<u>11/3/09</u> Date
Send a copy indicating approved/denied to the LANL Requestor and Eng Stds Mgr.			