



**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 °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 °F.
The allowable stress for annealed copper is 5100 psi at 150 °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 °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 °F.

Maximum Allowable Pressures in Copper at 100 °F

| Nominal Standard 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 Standard 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 | <input checked="" type="checkbox"/> 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)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> 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 Owing 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 |
|--|--------------------|--------------------------------|------------------|