TN 21-2663 (B31.3 SG-G)
ERRATA to B31.3-2020
Error was made during publication of TN 16-2376

December 2021

Errata

Proposal: Delete negative exponent from equation (34b).

Rationale: Record 16-2376 incorrectly copied the "CURRENT" Code text to include a negative exponent in Equation (34b). This negative exponent also appeared in the "PROPOSED" text, but there was no indication that it was a change from what is actually in ASME B31.3-2018. Furthermore, the Background of Record 16-2376 also indicates that no change to the wall thickness equations are required. This errata makes the negative exponent a positive one.

See next page for Errata followed by additional background information.

$c = c_i + c_o$
= the sum of mechanical allowances[2] (thread or groove depth) plus corrosion and erosion allowances (where c_i = the sum of *internal* allowances and c_o = the sum of *external* allowances). For threaded components, the nominal thread depth (dimension h of ASME B1.20.1 or equivalent) shall apply, except that for straight threaded connections, the external thread groove depth need not be considered provided
(1) it does not exceed 20% of the wall thickness
(2) the ratio of outside to inside diameter, D/d, is greater than 1.1
(3) the internally threaded attachment provides adequate reinforcement
(4) the thread plus the undercut area, if any, does not extend beyond the reinforcement for a distance more than the nominal wall thickness of the pipe

t = pressure design wall thickness, as calculated in para. K304.1.2 for internal pressure, or in accordance with the procedure listed in para. K304.1.3 for external pressure

t_m = minimum required wall thickness, including mechanical, corrosion, and erosion allowances

Adequate reinforcement by the attachment is defined as that necessary to ensure that the static burst pressure of the connection will equal or exceed that of the unthreaded portion of the pipe. The adequacy of the reinforcement shall be substantiated as required by para. K304.7.2.

(20) **K304.1.2 Straight Pipe Under Internal Pressure.** The internal pressure design wall thickness, t, shall be not less than that calculated in accordance with eq. (34a) for pipe with a specified outside diameter and minimum wall thickness, or eq. (34b) for pipe with a specified inside diameter and minimum wall thickness[3]

$$t = \frac{D - 2c_o}{2}\left[1 - e^{(-P/S)}\right] \quad (34a)$$

or

$$t = \frac{d + 2c_i}{2}\left[e^{(P/S)} - 1\right] \quad (34b)$$

Alternatively, the internal design gage pressure, P, may be calculated by eq. (35a) or (35b)[3]

$$P = S \times \ln\left[\frac{D - 2c_o}{D - 2(T - c_i)}\right] \quad (35a)$$

or

$$P = S \times \ln\left[\frac{d + 2(T - c_o)}{d + 2c_i}\right] \quad (35b)$$

where
D = outside diameter of pipe. For design calculations in accordance with this Chapter, the outside diameter of the pipe is the maximum value allowable under the specifications.
d = inside diameter of pipe. For design calculations in accordance with this Chapter, the inside diameter of the pipe is the maximum value allowable under the specifications.
P = internal design gage pressure
S = allowable stress from Table K-1
T = pipe wall thickness (measured or minimum in accordance with the purchase specification)

(20) **K304.1.3 Straight Pipe Under External Pressure.** The pressure design thickness for straight pipe under external pressure shall be determined in accordance with para. K304.1.2. Straight pipe under external pressure shall also meet the criteria against buckling given in ASME BPVC, Section VIII, Division 3, Article KD-2, KD-222.

K304.2 Curved and Mitered Segments of Pipe

K304.2.1 Pipe Bends. The minimum required wall thickness, t_m, of a bend, after bending, may be determined as for straight pipe in accordance with para. K304.1, provided that the bend radius of the pipe centerline is equal to or greater than ten times the nominal pipe outside diameter and the tolerances and strain limits of para. K332 are met. Otherwise the design shall be qualified as required by para. K304.7.2.

K304.2.2 Elbows. Manufactured elbows not in accordance with para. K303 and pipe bends not in accordance with para. K304.2.1 shall be qualified as required by para. K304.7.2.

K304.2.3 Miter Bends. Miter bends are not permitted.

(20) **K304.2.4 Curved Segments of Pipe Under External Pressure.** The wall thickness of curved segments of pipe subjected to external pressure may be determined as specified for straight pipe in para. K304.1.3.

K304.3 Branch Connections

K304.3.1 General. Acceptable branch connections include a fitting in accordance with para. K303, an extruded outlet in accordance with para. 304.3.4, or a

[2] For machined surfaces or grooves where the tolerance is not specified, the tolerance shall be assumed to be 0.5 mm (0.02 in.) in addition to the specified depth of the cut.

[3] Any mechanical, corrosion, or erosion allowance, c, not specified as internal, c_i, or external, c_o, shall be assumed to be internal, i.e., $c = c_i$ and $c_o = 0$.

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equivalent) shall apply, except that for straight threaded connections, the external thread groove depth need not be considered provided

(a) it does not exceed 20% of the wall thickness;

(b) the ratio of outside to inside diameter, D/d, is greater than 1.1;

(c) the internally threaded attachment provides adequate reinforcement; and

(d) the thread plus the undercut area, if any, does not extend beyond the reinforcement for a distance more than the nominal wall thickness of the pipe.

t = pressure design wall thickness, as calculated in para. K304.1.2 for internal pressure, or in accordance with the procedure listed in para. K304.1.3 for external pressure

t_m = minimum required wall thickness, including mechanical, corrosion, and erosion allowances

Adequate reinforcement by the attachment is defined as that necessary to ensure that the static burst pressure of the connection will equal or exceed that of the unthreaded portion of the pipe. The adequacy of the reinforcement shall be substantiated as required by para. K304.7.2.

(18) **K304.1.2 Straight Pipe Under Internal Pressure**

(a) Except as provided in (b) below for solution heat treated austenitic stainless steels and certain nickel alloys with similar stress–strain behavior, the internal pressure design wall thickness, t, shall be not less than that calculated in accordance with eq. (34a) for pipe with a specified outside diameter and minimum wall thickness, or eq. (34b) for pipe with a specified inside diameter and minimum wall thickness[3,4]

$$t = \frac{D - 2c_o}{2}\left(1 - e^{-P/S}\right) \tag{34a}$$

or

$$t = \frac{d + 2c_i}{2}\left(e^{P/S} - 1\right) \tag{34b}$$

Alternatively, the internal design gage pressure, P, may be calculated by eq. (35a) or (35b)[3,4]

$$P = S \times \ln\left[\frac{D - 2c_o}{D - 2(T - c_i)}\right] \tag{35a}$$

or

$$P = S \times \ln\left[\frac{d + 2(T - c_o)}{d + 2c_i}\right] \tag{35b}$$

where

D = outside diameter of pipe. For design calculations in accordance with this Chapter, the outside diameter of the pipe is the maximum value allowable under the specifications.

d = inside diameter of pipe. For design calculations in accordance with this Chapter, the inside diameter of the pipe is the maximum value allowable under the specifications.

P = internal design gage pressure

S = allowable stress from Table K-1

T = pipe wall thickness (measured or minimum in accordance with the purchase specification)

(b) At design temperatures where allowable stress, S, values in Table K-1 are in **boldface** (solution heat treated austenitic stainless steels and certain nickel alloys with similar stress–strain behavior only), the internal pressure design wall thickness, t, shall be not less than that calculated in accordance with eq. (34c) for pipe with a specified outside diameter and minimum wall thickness, or eq. (34d) for pipe with a specified inside diameter and minimum wall thickness[3,4]

$$t = \frac{D - 2c_o}{2}\left(1 - e^{-1.155P/S}\right) \tag{34c}$$

or

$$t = \frac{d + 2c_i}{2}\left(e^{1.155P/S} - 1\right) \tag{34d}$$

Alternatively, the internal design gage pressure, P, may be calculated by eq. (35c) or (35d)[3,4]

$$P = \frac{S}{1.155}\ln\left[\frac{D - 2c_o}{D - 2(T - c_i)}\right] \tag{35c}$$

or

$$P = \frac{S}{1.155}\ln\left[\frac{d + 2(T - c_o)}{d + 2c_i}\right] \tag{35d}$$

K304.1.3 Straight Pipe Under External Pressure. The pressure design thickness for straight pipe under external pressure shall be determined in accordance with para. K304.1.2 for pipe where $D/t < 3.33$, if at least one end of the pipe is exposed to full external pressure, producing a compressive axial stress. For $D/t \geq 3.33$, and for $D/t < 3.33$ where external pressure is not applied to at least one end of the pipe, the pressure design wall thickness shall be determined in accordance with para. 304.1.3 except that the stress values shall be taken from Table K-1.

[3] The intent of these equations is to provide a factor of not less than 1.732 (or $\sqrt{3}$) on the pressure required, according to the von Mises theory, to initiate yielding on the outside surface of a cylinder made from an elastic-perfectly plastic material. For solution heat treated austenitic stainless steels and certain nickel alloys with similar stress–strain behavior, this factor is as low as approximately 1.5 at elevated temperatures.

[4] Any mechanical, corrosion, or erosion allowance, c, not specified as internal, c_i, or external, c_o, shall be assumed to be internal, i.e., $c = c_i$ and $c_o = 0$.

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consequence, the margin against yielding at the outside surface at this test pressure is increased to 1.39.

$$\frac{P_{CN}}{P_T} = \frac{\frac{2}{\sqrt{3}} S_y Ln(Y)}{1.25 \times \frac{2}{3} S_y Ln(Y)} = \frac{2 \times 3}{1.25 \times 2 \times \sqrt{3}} = 1.39$$

Previous code versions used a hydrotest pressure of 1.5. In this case, the margin against yielding at the outside surface at test pressure is 1.15. This is the same as in the 2013 of ASME VIII division 3.

$$\frac{P_{CN}}{P_T} = \frac{\frac{2}{\sqrt{3}} S_y Ln(Y)}{1.5 \times \frac{2}{3} S_y Ln(Y)} = \frac{2}{\sqrt{3}} = 1.15$$

6 ASME B31.3 Chapter IX (Proposed)

It is proposed to use the principles that underlie ASME VIII Division 3 equation KD-221.2 to determine the design pressure of a pipe under internal pressure.

The most significant impact to the current allowable stresses is the reduction in hydrotest pressure to 1.25 times design pressure.

Closed-end cylindrical shell and open-end cylindrical shell for Y > 2.85:

$$P_D = \min \left(\left[\frac{1}{1.25} (S_y) \ln(Y) \right], \left[\frac{1}{3} (S_y + S_u) \ln(Y) \right] \right) \qquad \text{(KD-221.2)}$$

The complexity of introducing new equations and moving away from the principle of using an allowable stress basis does not have to be introduced. By comparison with ASME B31.3 equation (35a), it can be seen that:

- if the allowable stress is calculated as a minimum of $\left(\frac{1}{1.25} S_y\right)$ or $\left(\frac{1}{3}(S_y + S_u)\right)$
- then the Chapter IX equations remain unchanged and the principle of using an allowable stress basis can be maintained.

An example is shown in Table 1.

	2016 (ksi)	Proposed (ksi)					
	Allowable stress	Yield	UTS	ratio	Hydrotest	Burst	Allowable stress
	S	S_y	S_u	$\frac{S_y}{S_u}$	$\frac{1}{1.25} S_y$	$\frac{1}{3}(S_y + S_u)$	S
API 5L X 42	28	42	60	0.7	33.6	34.0	33.6
API 5L X 60	40	60	75	0.8	50.0	45.0	45.0

Table 1: Change in Appendix K allowable stress

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14 August 2018 Editorial Revisions in Orange Underline and ~~Orange Strikethrough~~

19 May 2018 Editorial Revisions in Blue and Blue Strikethrough

Background Information

B31.3 Standards Action No. 16-2376

ASME B31.3 Agenda Item G-14-09

CURRENT	**PROPOSED**
$t = \frac{D-2c_o}{2}\left[1 - e^{\left(\frac{-P}{S}\right)}\right]$ (34a)[4,5]	$t = \frac{D-2c_o}{2}\left[1 - e^{\left(\frac{-P}{S}\right)}\right]$ (34a)[4,5]
or	or
$t = \frac{d+2c_i}{2}\left[e^{\left(\frac{-P}{S}\right)} - 1\right]$ (34b)[4,5]	$t = \frac{d+2c_i}{2}\left[e^{\left(\frac{-P}{S}\right)} - 1\right]$ (34b)[4,5]
Alternatively, the internal design gage pressure, *P*, may be calculated by eq. (35a) or (35b).	Alternatively, the internal design gage pressure, *P*, may be calculated by eq. (35a) or (35b).
$P = S \times ln\left[\frac{D-2c_o}{D-2(T-c_i)}\right]$ (35a)[4,5]	$P = S \times ln\left[\frac{D-2c_o}{D-2(T-c_i)}\right]$ (35a)[4,5]
or	or
$P = S \times ln\left[\frac{d+2(T-c_o)}{d+2c_i}\right]$ (35b)[4,5]	$P = S \times ln\left[\frac{d+2(T-c_o)}{d+2c_i}\right]$ (35b)[4,5]
Where	Where
D = outside diameter of pipe. For design calculations in accordance with this Chapter, the outside diameter of the pipe is the maximum value allowable under the specifications.	*D* = outside diameter of pipe. For design calculations in accordance with this Chapter, the outside diameter of the pipe is the maximum value allowable under the specifications.
d = inside diameter of pipe. For design calculations in accordance with this Chapter, the inside diameter of the pipe is the maximum value allowable under the specifications.	*d* = inside diameter of pipe. For design calculations in accordance with this Chapter, the inside diameter of the pipe is the maximum value allowable under the specifications.
P = internal design gage pressure	*P* = internal design gage pressure
S = allowable stress from Table K-1	*S* = allowable stress from Table K-1
T = pipe wall thickness (measured or minimum in accordance with the purchase specification)	*T* = pipe wall thickness (measured or minimum in accordance with the purchase specification)
(b) At design temperatures where allowable stress, *S*, values in Table K-1 are in **boldface** (solution heat treated austenitic stainless steels and certain nickel alloys with similar stress–strain behavior only), the internal pressure design wall thickness, *t*, shall be not less than that calculated in accordance with eq. (34c) for pipe with a specified outside diameter and minimum wall thickness, or eq. (34d) for pipe with a specified inside diameter and minimum wall thickness.	~~*(b)* At design temperatures where allowable stress, *S*, values in Table K-1 are in **boldface** (solution heat treated austenitic stainless steels and certain nickel alloys with similar stress–strain behavior only), the internal pressure design wall thickness, *t*, shall be not less than that calculated in accordance with eq. (34c) for pipe with a specified outside diameter and minimum wall thickness, or eq. (34d) for pipe with a specified inside diameter and minimum wall thickness.~~
$t = \frac{D-2c_o}{2}\left[1 - exp\left(\frac{-1.155P}{S}\right)\right]$ (34c)[4,5]	~~$t = \frac{D-2c_o}{2}\left[1 - exp\left(\frac{-1.155P}{S}\right)\right]$ (34c)[4,5]~~
or	~~or~~