NONMANDATORY APPENDIX Y
EVALUATION OF THE DESIGN OF RECTANGULAR AND HOLLOW CIRCULAR CROSS SECTION WELDED ATTACHMENTS ON PIPING

ARTICLE Y-1000
INTRODUCTION AND SCOPE

Y-1100 INTRODUCTION

Y-1110 SCOPE

(a) The Articles of this Appendix provide rules and service limits which may be used to evaluate the design of both rectangular cross section and hollow circular cross section welded attachments on pipe.

(b) This Appendix is limited to use in Division 1, Subsection NB, NC, and ND, and Division 5, Subsection HB, Subpart A and Subsection HC, Subpart A piping systems.

(c) The rules presented here are not intended to exclude other methods such as finite element analyses.
**Y-3400 EVALUATION PROCEDURE**

The loads on the attachment cause stresses in the pipe wall. Equations are provided in Y-3410(a) to determine these stresses. The attachment stresses are then added to the piping system stresses at the attachment. The piping system stresses are determined by NC-3652 eq. (8), NC-3653.1 eq. (9), and NC-3653.2 eqs. (10a), (10b), and (11) for straight pipe. The Code equations including the attachment stress terms are given in Y-3410(b). The attachment stresses \( S_{ml}, S_{nl}, \) and \( S_{pl} \) are to be calculated for the loading conditions corresponding to NC-3652 eq. (8), NC-3653.1 eq. (9), and NC-3653.2 eqs. (10a), (10b), and (11). For example, in calculating \( S_{ml} \) for use in NC-3652 eq. (8), \( W, M_L, M_N, Q_1, Q_2, \) and \( M_T \) are the loads on the attachment due to weight and other sustained loads. While NC is used below, the same rules apply for ND piping.

There are additional equations given in Y-3410(c) for all weld configurations and Y-3420(b) for attachments welded with fillet or partial penetration welds that also must be checked for attachment stresses. These are based on the absolute values for maximum loads occurring simultaneously for Level A, B, C, or D service loading conditions.

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Delete this last sentence "While NC ...". 

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ARTICLE Y-5000
PROCEDURE FOR EVALUATION OF THE DESIGN OF HOLLOW CIRCULAR CROSS SECTION WELDED ATTACHMENTS ON CLASS 2 AND 3 PIPING

Y-5100 INTRODUCTION

Y-5110 SCOPE

This Article provides rules and service limits which may be used to evaluate the design of hollow circular cross section welded attachments on Class 2 and 3 pipe under Section III, Division 1.

Y-5200 LIMITATIONS TO APPLICABILITY

(a) The attachment shall be welded to the pipe along the entire circumference by either a full penetration weld, a fillet weld, or a partial penetration weld.

(b) The attachment material and pipe material shall have essentially the same moduli of elasticity and coefficients of thermal expansion.

(c) The constants defined in Y-5300 fall within the following ranges:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>4.0 ≤ γ ≤ 50.0</td>
</tr>
<tr>
<td>(2)</td>
<td>0.2 ≤ τ ≤ 1.0</td>
</tr>
<tr>
<td>(3)</td>
<td>0.3 ≤ β ≤ 1.0</td>
</tr>
<tr>
<td>(4)</td>
<td>the axis of the attachment is perpendicular to the axis of the run pipe</td>
</tr>
</tbody>
</table>

(d) The attachment is made on straight pipe, with the nearest edge of the attachment weld located at a minimum distance of \( \sqrt{RT} \) from any other weld or other discontinuity (see Y-5300 for definitions of \( R \) and \( T \)). For multiple attachments located at a distance less than \( \sqrt{RT} \) to each other, the stress effects for each individual attachment shall be superimposed.

Y-5300 NOMENCLATURE AND DEFINITIONS

The nomenclature defined below is used in the equations and figures of this Article.

\[
A_T = \pi (r_o^2 - r_i^2)
\]

\[
A_w = \text{fillet weld or partial penetration weld throat area, in.}^2 \text{ (mm}^2) \]

\[
B_L = 0.5 \ (C_L), \text{ but not less than 1.0}
\]

\[
B_N = 0.5 \ (C_N), \text{ but not less than 1.0}
\]

\[
B_T = 0.5 \ (C_T), \text{ but not less than 1.0}
\]

\[
B_W = 0.5 \ (C_W), \text{ but not less than 1.0}
\]

\[
C = A_o(2\gamma^\alpha \beta^n \tau^n J^n \beta^n t^n) \text{ but not less than 1.0}
\]

\[
C_T = 1.0 \text{ for } \beta \leq 0.55
\]

\[
= C_N \text{ for } \beta = 1.0, \text{ but not less than 1.0}; \] \( C_T \) should be linearly interpolated for \( 0.55 < \beta < 1.0, \text{ but not less than 1.0} \)

\[
D_o = \text{outside diameter of run pipe, in. (mm)}
\]

\[
d_o = \text{outside diameter of attachment, in. (mm)}
\]

\[
l_T = \frac{\pi}{4} (r_o^4 - r_i^4)
\]

\[
J = \text{lesser of } \pi r_o^2 T \text{ or } Z_T
\]

\[
K_T = 1.8 \text{ for full penetration welds}
\]

\[
= 2.0 \text{ for fillet or partial penetration welds}
\]

\[
M_L = \text{bending moment applied to the attachment as shown in Figure Y-5300-1, in.-lb (kN-m)}
\]

\[
M_N = \text{bending moment applied to the attachment as shown in Figure Y-5300-1, in.-lb (kN-m)}
\]

\[
M_T = \text{torsional moment applied to the attachment as shown in Figure Y-5300-1, in.-lb (kN-m)}
\]

\[
Q_1 = \text{shear load applied to the attachment as shown in Figure Y-5300-1, lb (kN)}
\]

\[
Q_2 = \text{shear load applied to the attachment as shown in Figure Y-5300-1, lb (kN)}
\]

\[
R = \text{mean run pipe radius, in. (mm)}
\]

\[
r_i = \text{attachment inside radius, in. (mm)}
\]

\[
r_o = \text{run pipe outside radius, in. (mm)}
\]

\[
r_{lo} = \text{attachment outside radius, in. (mm)}
\]

\[
S_A = \pi (1.25S_L + 0.25S_h), \text{ psi (kPa), as defined in NCD-3611.2 (lesser of attachment or pipe material allowable)}
\]
These stresses. The attachment stresses are then added to the piping system stresses at the pipe wall. Equations are provided in Y-5410(a) to determine the values of maximum loads occurring simultaneously under all service loading conditions.

The loads on the attachment cause stresses in the pipe. The values of attachment loads used in the different Code equations.

**Y-5400 EVALUATION PROCEDURE**

The loads on the attachment cause stresses in the pipe wall. Equations are provided in Y-5410(a) to determine these stresses. The attachment stresses are then added to the piping system stresses at the attachment. The piping system stresses are determined by NC-3652 eq. (8), NC-3653.1 eq. (9), and NC-3653.2 eqs. (10a), (10b), and (11) for straight pipe. The Code equations including the attachment stress terms are given in Y-5410(b). The attachment stresses, $S_{MT}$, $S_{NT}$, and $S_{PT}$ are to be calculated for the loading conditions corresponding to NC-3652 eq. (8), NC-3653.1 eq. (9), and NC-3653.2 eqs. (10a), (10b), and (11). For example, in calculating $S_{MT}$ for use in NC-3652 eq. (8), $W$, $M_L$, $M_N$, $Q_1$, $Q_2$, and $M_T$ are the loads on the attachment due to weight and other sustained loads. While NC is used below, the same rules apply for ND piping.

There are additional equations given in Y-5410(c) for all weld configurations and Y-5420(b) for fillet weld or partial penetration weld attachments, that also must be checked for attachment stresses. These are based on the absolute values for maximum loads occurring simultaneously under all service loading conditions.

**Y-5410 ANALYSIS OF ATTACHMENT WELDED TO PIPE WITH A FULL PENETRATION WELD**

(a) Calculate the stresses: $S_{MT}$, $S_{NT}$, $S_{PT}$, and $S_{NT}^{**}$

$$S_{MT} = \frac{B_WW}{A_T} + \frac{B_WM_N}{Z_T} + \frac{B_WM_N}{Z_T} + \frac{2Q_1}{A_T} + \frac{2Q_2}{A_T} + \frac{B_WM_T}{Z_T}$$

(b) The following modified Code equations shall be satisfied, where all terms except attachment stresses are defined in NC-3652.

(1) NC-3652 eq. (8) becomes

$$S_{SL} = B_1 \frac{PD_0}{2t_n} + B_2 \frac{MA}{Z} + S_{MT} \leq 1.8S_h$$

where $B_1 = 0.5$ and $B_2 = 1.0$ for straight pipe.

(2) NC-3653.1 eq. (9) becomes

$$S_{OL} = B_1 \frac{P_{max}D_0}{2t_n} + B_2 \frac{MA}{Z} + B_2 \frac{MA}{Z} + S_{MT} \leq 1.8S_y$$

For Level A and B loadings, $S_{OL} \leq 1.8S_h$ and $S_{OL} \leq 1.8S_y$.

For Level C loadings, $S_{OL} \leq 2.25S_h$ and $S_{OL} \leq 1.8S_y$.  

### Index Table

<table>
<thead>
<tr>
<th>Index</th>
<th>Part</th>
<th>$\beta$ Range</th>
<th>$A_n$</th>
<th>$n_2$</th>
<th>$n_3$</th>
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<tr>
<td>$C_W$</td>
<td>Pipe</td>
<td>0.3–1.0</td>
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<td>[Note (1)] 1.33</td>
</tr>
<tr>
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<td>0.3–1.0</td>
<td>4.00</td>
<td>0.55</td>
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<td>Pipe</td>
<td>0.3–1.0</td>
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<td>-0.38 0.38</td>
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<td>0.85</td>
<td>0.80 0.54</td>
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<td>0.44</td>
<td>0.85</td>
<td>-0.28 0.54</td>
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</tbody>
</table>

**NOTES:**

(1) Replace $\beta^{(1.2\beta_n)}$ with $\beta^{(1.2\beta_n)}$.

(2) Replace $\beta^{(1.35\beta_n)}$ with $\beta^{(1.35\beta_n)}$.

$M_L$, $M_N$, $M_T$, $Q_1$, $Q_2$, and $W$ are determined at the surface of the pipe. The values of attachment loads used in the stress evaluation (Y-5400) are based on the loads used in the different Code equations.

$M_{LT}^{**}$, $M_{NT}^{**}$, $M_{PT}^{**}$, $Q_1^{**}$, $Q_2^{**}$, and $W^{**}$ are absolute values of maximum loads occurring simultaneously under all service loading conditions.
For Level D loadings, $S_{OL} \leq 3.0S_h$ and $S_{OL} \leq 2.0S_y$.

(3) \( NC \) 3653.2 eq. (10a) becomes

$$S_E = \frac{iM_c}{Z} + \frac{S_{PT}}{2} \leq S_A \quad (NC-10a)$$

(4) \( NC \) 3653.2 eq. (10b) becomes

$$\frac{iM_d}{Z} + \frac{S_{PT}}{2} \leq 3.0S_c \quad (NC-10b)$$

(5) \( NC \) 3653.2 eq. (11) becomes

$$S_{TE} = \frac{PD_c}{4t_n} + 0.75\left(\frac{M_A}{Z} + i\frac{M_c}{Z}\right) + S_{MT} + \frac{S_{PT}}{2} \leq \left(S_h + S_A\right) \quad (NC-11)$$

In eq. (NC-11), $S_{MT}$ is the same as used in eq. (1)(NC-8), and $S_{PT}$ is the same as used in eq. (3)(NC-10a).

(c) In addition to the Code equations, the following equations shall also be satisfied.

$$S_{NT}^{**} \leq 2S_y \quad (5)$$

$$\frac{2Q_1^{**}}{A_T} + \frac{2Q_2^{**}}{A_T} + \frac{M_T^{**}}{J} \leq S_y \quad (6)$$

Y-5420 ANALYSIS OF ATTACHMENT WELDED TO PIPE WITH FILLET WELDS OR PARTIAL PENETRATION WELDS

(a) The requirements of Y-5410 shall be met.

(b) The following additional requirements shall be met.

$$\frac{W^{**}}{A_w} + \frac{M_n^{**}}{Z_{wl}} + \frac{M_n^{**}}{Z_{wn}} + \left[\left(\frac{Q_1^{**}}{A_w}\right)^2 + \left(\frac{Q_2^{**}}{A_w}\right)^2\right]^{1/2} \leq S_y \quad (7)$$

$$\left[\left(\frac{W^{**}}{A_w}\right)^2 + 4\left(\frac{Q_1^{**} + Q_2^{**}}{A_w}\right) + \frac{M_T^{**}}{Z_{wt}}\right]^{1/2} \leq S_y \quad (8)$$

Y-5430 DIFFERENTIAL METAL TEMPERATURE EFFECTS

The potential for increased stress at the attachment welds, which may occur as a result of differential metal temperatures between the attachment and the run, should be considered in the design evaluation.

Y-5500 ANALYSIS DOCUMENTATION

Analyses demonstrating compliance with this Article shall be included in the Design Report for the piping system.