CASE N-500-4
Alternative Rules for Standard Supports for Classes 1, 2, 3 and MC
Section III, Division 1

Inquiry: What alternative rules to Section III, Subsection NCA and NF may be used for the construction of Class 1, 2, 3 and MC Standard Supports?

Reply: It is the opinion of the Committee that, as an alternative to the requirements of NCA and NF, Class 1, 2, 3 and MC Standard Supports, except dampers (NF-3412.5), snubbers, and struts (Type 47, Fig. A1 of ANSI/MSS SP-58-2009), and their associated attachments, may be constructed to ANSI MSS SP-58-2009, "Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation," and the following additional requirements:

1 MATERIALS

1.1 The materials and allowable stresses listed in Table A2 of ANSI MSS SP-58 - 2009 may be used, except for A48, A126, A395 and A536 castings.

1.2 The use of other materials per 3.2 of ANSI MSS SP-58 - 2009 is limited to material specifications permitted for use for any type or class of support under Subsection NF including those permitted by a Code Case applicable to Subsection NF, except that the allowable stresses shall be calculated in accordance with ANSI MSS SP-58 - 2009.

1.3 Certified Material Test Reports in accordance with NCA-3867.4(a) shall be supplied with the Standard support for all materials except carbon steel materials with a specified minimum tensile strength of 75,000 psi or less, exempt materials as identified in NF-2121(b), or small products as defined in NF-2610(c).

1.4 The identification of materials requiring Certified Material Test Reports shall meet the requirements of NCA-3856.

2 DESIGN

2.1 For Design and Service Level A, stresses shall not exceed those of ANSI MSS SP-58 - 2009.

2.2 For Service Level B, stresses shall not exceed 1.33 times those of ANSI MSS SP-58 - 2009.

2.3 For Service Level C, stresses shall not exceed 1.50 times those of ANSI MSS SP-58 - 2009.

2.4 For Service Level D, stresses shall not exceed 2.0 times those of ANSI MSS SP-58 - 2009.

2.5 The stresses caused by Test loadings shall be limited to 80% of the tabulated value of yield stress.

2.6 For all service levels, tensile and compressive stresses shall not exceed 70% of the tabulated value of ultimate tensile strength at the service temperature and shear stresses shall not exceed 42% of the tabulated value of ultimate tensile strength at the service temperature. Stresses shall not exceed 50% of critical buckling stress for Design, Level A and Level B and 67% of critical buckling stress for Level C, Level D and Test. Consideration shall be given to combinations of stresses.

2.7 The requirements of NF-3330 "High Cycle Fatigue Design for Class 1" shall be met for Class 1 supports.

2.8 The requirements of NF-3225 "Design of Bolting" and NF-3324.6 "Design Requirements for Bolted Joints" shall be met.

2.9 Section 11.3 of ANSI MSS SP-58 - 2009 shall not be used. Supports may be designed by load rating in accordance with NF-3480 using the allowable stresses in 2.1 through 2.8.

3 QUALITY ASSURANCE

3.1 The standard supports shall be manufactured under a quality assurance program which meets the requirements specified by the purchaser.

4 OTHER REQUIREMENTS

4.1 The use of this Code Case shall be in accordance with NCA-1140 and shall be listed on the applicable data report for the component which utilizes the standard support.

4.2 All welds shall be visually examined to the acceptance standards of NF-5360.

(Note to Editor: Changes from N-500-3 are shown in Bold, Italics.)
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2.2 For Service Level B, stresses shall not exceed 1.33 times those of ANSI MSS SP-58 - 2009.

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4.2 All welds shall be visually examined to the acceptance standards of NF-5360.

(Note to Editor: Changes from N-500-3 are shown in Bold, Italics.)
**TABLE XI-3240-1**

<table>
<thead>
<tr>
<th>Integral Flange</th>
<th>Loose Hub Flange</th>
</tr>
</thead>
<tbody>
<tr>
<td>For $F$ (Fig. XI-3240-2) use:</td>
<td>For $F_L$ (Fig. XI-3240-4) use:</td>
</tr>
<tr>
<td>$F = - \frac{E_6}{(C/2.73)^{1/4}(1 + A)^3} \frac{C}{C}$</td>
<td>$F_L = \frac{C_1\left(\frac{1}{2} + \frac{A}{6}\right) + C_{21}\left(\frac{1}{4} + \frac{11A}{84}\right) + C_{24}\left(\frac{1}{70} + \frac{A}{105}\right) - \left(\frac{1}{40} + \frac{A}{72}\right)}{(C/2.73)^{1/4}(1 + A)^3} \frac{C}{C}$</td>
</tr>
</tbody>
</table>

For $V$ (Fig. XI-3240-3) use:

$$V = \frac{E_4}{(C/2.73)^{1/4}(1 + A)^3}$$

For $f$ (Fig. XI-3240-6) use:

$$f = C_{36}/(1 + A)$$

**NOTE:** Except for the case when $g_1 = g_2$, the values used in the formulas given above are determined by using Eqs. (1) through (45), which are based on the values of $g_1$, $g_2$, $h$, and $h_0$ (see XI-3130 for definitions). When $g_1 = g_2$, Eqs. (1) through (45) are not required and should not be used. For this case ($g_1 = g_2$), $F = 0.908920$, $V = 0.550103$, and $f = 1$

**Equations**

1. $A = (g_1/g_2) - 1$
2. $C = 43.68(h/h_0)^4$
3. $C_1 = 1/3 + A/12$
4. $C_2 = 5/42 + 17A/336$
5. $C_3 = 1/210 + A/360$
6. $C_4 = 11/360 + 59A/5040 + (1 + 3A)/C$

D-3
Figure NB-3221-1
Stress Categories and Limits of Stress Intensity for Design Conditions

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>General Membrane</th>
<th>Primary</th>
<th>Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description (for examples see Table NB-3217-1)</td>
<td>Average primary stress across solid section. Excludes discontinuities and concentrations. Produced only by mechanical loads.</td>
<td>Average stress across any solid section. Considers discontinuities but not concentrations. Produced only by mechanical loads.</td>
<td>Component of primary stress proportional to distance from centroid of solid section. Excludes discontinuities and concentrations. Produced only by mechanical loads. (Note 1))</td>
</tr>
<tr>
<td>Symbol (Note 2))</td>
<td>$P_m$</td>
<td>$P_a$</td>
<td>$P_b$</td>
</tr>
</tbody>
</table>

Combination of stress components and allowable limits of stress intensities.

$P_m$ $S_m$ $P_a$ $1.5S_m$ $P_a + P_b$ $1.5S_m$

Legend

Use Design Loads

NOTES:
(1) Bending component of primary stress for piping shall be the stress proportional to the distance from centroid of pipe cross section.
(2) The symbols $P_m$, $P_a$, and $P_b$ do not represent single quantities, but rather sets of six quantities representing the six stress components $\sigma_r$, $\sigma_\theta$, $\sigma_z$, $\tau_{rz}$, and $\tau_{\theta z}$. 
### Stress Categories and Limits of Stress Intensity for Level A and Level B Service Limits

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>General Membrane</th>
<th>Local Membrane</th>
<th>Bending</th>
<th>Expansion</th>
<th>Membrane plus Bending</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Average primary stress across solid section. Excludes effects of discontinuities and concentrations. Produced by pressure and mechanical loads.</td>
<td>Average stress across any solid section. Considers effects of discontinuities but not concentrations.</td>
<td>Component of primary stress proportional to distance from centroid of solid section. Excludes effects of discontinuities and concentrations. Produced by pressure and mechanical loads, including inertia effects.</td>
<td>Stresses which result from the constraint of free end displacement. Considers effects of discontinuities but not local stress concentration (not applicable to vessels).</td>
<td>Self-equilibrating stress necessary to satisfy continuity of structure. Occurs at structural discontinuities. Can be caused by pressure, mechanical loads, or differential thermal expansion. Excludes local stress concentrations.</td>
<td>(1) Increment added to primary or secondary stress by a concentration (notch). (2) Certain thermal stresses which may cause fatigue but not distortion.</td>
</tr>
<tr>
<td>Symbol</td>
<td>$P_m$ (Note (3))</td>
<td>$P_L$ (Note (3))</td>
<td>$P_b$ (Note (3))</td>
<td>$P_e$</td>
<td>$Q$</td>
<td>$F$</td>
</tr>
</tbody>
</table>

#### Legend
- **Allowable Value**
- **Calculated Value**
- **Service Condition Loads**

#### Notes:
1. Bending component of primary stress due to mechanical loads for piping shall be the stress proportional to the distance from centroid of pipe cross-section. For piping, the calculation of $P_b$ stresses is not required for reversing dynamic loads (including inertia earthquake effects). See NB-3223(b)(2).
2. The symbols $P_m$, $P_L$, $P_b$, $P_e$, $Q$, and $F$ do not represent single quantities, but sets of six quantities representing the six stress components $\sigma_p$, $\sigma_b$, $\tau_m$, $\tau_L$, $\tau_e$, and $\tau_F$.
3. For Level B Service Limits for primary stress intensities generated by Level B Service Loadings, see NB-3223(e)(1).
Stress Categories and Limits of Stress Intensity for Level A and Level B Service Limits (Cont'd)

NOTES (CONT'D):

(4) When the secondary stress is due to a temperature transient at the point at which the stresses are being analyzed or to restraint of free end deflection, the value of $S_m$ shall be taken as the average of the tabulated $S_m$ values for the highest and lowest temperatures of the metal during the transient. When part or all of the secondary stress is due to mechanical load, the value of $S_m$ shall not exceed the value for the highest temperature during the transient.

(5) Special rules for exceeding $3S_m$ are provided in NB-3228.5.

(6) $S_m$ is obtained from the fatigue curves, Figure I-9.0. The allowable stress intensity for the full range of fluctuation is $2S_m$.

(7) The stresses in category Q are those parts of the total stress that are produced by thermal gradients, structural discontinuities, etc., and they do not include primary stresses that may also exist at the same point. However, it should be noted that a detailed stress analysis frequently gives the combination of primary and secondary stresses directly and, when appropriate, this calculated value represents the total of $P_m + P_b + Q$, and not $Q$ alone. Similarly, if the stress in category F is produced by a stress concentration, the quantity $F$ is the additional stress produced by the notch above and above the nominal stress. For example, if a point has a nominal stress intensity $P_m$ and has a notch with a stress concentration factor $K$, then $P_m \leq S_m, P_b = Q, Q = 0, F = P_m (K - 1)$, and the peak stress intensity equals $P_m + P_m (K - 1) = KP_m$. However, $P_b$ is the total membrane stress that results from mechanical loads, including discontinuity effects, rather than a stress increment. Therefore, the $P_b$ value always includes the $P_m$ contribution.
### Figure NB-3224-1
Stress Categories and Limits of Stress Intensity for Level C Service Limits

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>General Membrane</th>
<th>Local Membrane</th>
<th>Bending</th>
<th>Secondary Membrane Plus Bending</th>
<th>Peak Membrane Plus Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description (for examples see Table NB-3217-1)</td>
<td>Average primary stress across solid section. Excludes discontinuities and concentrations. Produced only by mechanical loads.</td>
<td>Average stress across any solid section. Considers discontinuities but not concentrations. Produced only by mechanical loads.</td>
<td>Component of primary stress proportional to distance from centroid of solid section. Excludes discontinuities and concentrations. Produced only by mechanical loads.</td>
<td>Self-equilibrating stress necessary to satisfy continuity of structure. Occurs at structural discontinuities. Can be caused by mechanical load or by differential thermal expansion. Excludes local stress concentration.</td>
<td>(1) Increment added to primary or secondary stress by a concentration (notch). (2) Certain thermal stresses which may cause fatigue but not distortion of vessel shape.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol [Note (1)]</th>
<th>NB-3213.6 and NB-3213.8 [Note (3)]</th>
<th>NB-3213.10</th>
<th>NB-3213.7 and NB-3213.8</th>
<th>NB-3213.9</th>
<th>NB-3213.11</th>
</tr>
</thead>
</table>

### Combination of stress components and allowable limits of stress intensities

**Legend**
- **Allowable Value**
- **Calculated Value**
- **Service Condition Limits**

**GENERAL NOTE:** For configurations where compressive stresses occur, the stress limits shall be revised to take into account critical buckling stresses [NB-3211(c)].

**NOTES:**
1. The symbols \( P_m \), \( P_s \), \( Q \), and \( F \) do not represent single quantities, but rather sets of six quantities representing the six stress components \( \sigma_x, \sigma_y, \sigma_z, \tau_{xy}, \tau_{yz}, \) and \( \tau_{zx} \).
2. For piping, alternative requirements are provided in NB-3224.7.
3. The limits shown are for stresses resulting from pressure in combination with other mechanical loads. For ferritic materials, the \( P_m \) elastic analysis limits for pressure loadings alone shall be equal to the greater of 1.15\( P_m \) or 0.95\( P_m \).
4. Use the greater of the values specified.
5. \( Q \) is the collapse load calculated on the basis of the lower bound theorem of limit analysis and yield strength values specified in Section II, Part D, Subpart 1, Table Y-1.
6. The triaxial stresses represent the algebraic sum of the three principal stress values \( \sigma_1 + \sigma_2 + \sigma_3 \) for the combination of stress components.
FIG. NE-3221-1  STRESS CATEGORIES AND LIMITS OF STRESS INTENSITY FOR DESIGN CONDITIONS

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>General Membrane</th>
<th>Local Membrane</th>
<th>Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description (Table NE-3217-1)</td>
<td>Average primary stress across solid section. Excludes discontinuities and concentrations.</td>
<td>Average stress across any solid section. Considers discontinuities but not concentrations.</td>
<td>Component of primary stress proportional to distance from centroid of solid section. Excludes discontinuities and concentrations.</td>
</tr>
<tr>
<td>Symbol [Note (1)]</td>
<td>$P_m$</td>
<td>$P_l$</td>
<td>$P_a$</td>
</tr>
</tbody>
</table>

Combination Stress Components and Allowable Limits of Stress Intensities

Legend

- Allowable value
- Calculated value

Use Design Loads

$P_l + P_2 = 1.5 S_{ml}$ [Note (2)]

NOTES:
(1) The symbols $P_m$, $P_l$, and $P_a$ do not represent single quantities, but rather sets of six quantities representing the six stress components $\sigma_n$, $\sigma_b$, $\tau_\alpha$, $\tau_\beta$, $\tau_\gamma$, and $\tau_\delta$.
(2) Value shown is for a solid rectangular section. See NE-3221.3(d) for other than a solid rectangular section.
FIG. XIII-1141-1 STRESS CATEGORIES AND LIMITS OF STRESS INTENSITY

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>General Membrane</th>
<th>Local Membrane</th>
<th>Bending</th>
<th>Secondary Membrane Plus Bending</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Average primary stress across solid section. Excludes discontinuities and concentrations. Produced by pressure and mechanical loads.</td>
<td>Average stress across any solid sections. Considers discontinuities but not concentrations. Produced by pressure and mechanical loads.</td>
<td>Component of primary stress proportional to distance from centroid of solid section. Excludes discontinuities and concentrations. Produced by pressure and mechanical loads.</td>
<td>Self-equilibrating stress necessary to satisfy continuity of structure. Occurs at structural discontinuities. Can be caused by pressure, mechanical loads, or by differential thermal expansion. Excludes local stress concentrations.</td>
<td>(1) Increment added to primary or secondary stress by a concentration (notch). (2) Certain thermal stresses which may cause fatigue but not distortion of vessel shape.</td>
</tr>
<tr>
<td>Symbol</td>
<td>$P_m$</td>
<td>$P_L$</td>
<td>$P_b$</td>
<td>$Q$ (Note (2))</td>
<td>$F$</td>
</tr>
</tbody>
</table>

Combination of stress components and allowable limits of stress intensities

![Diagram showing combinations and allowable limits of stress intensities.]

Legend

- Use Design and Service Loads as appropriate.
- Use Service Loads only.

NOTES:

(1) The symbols $P_m$, $P_L$, $P_b$, $Q$, and $F$ do not represent single quantities but rather sets of six quantities representing the six stress components $a$, $b$, $c$, $d$, $e$, and $f$.

(2) The stresses in category $Q$ are those parts of the total stress which are produced by thermal gradients, structural discontinuities, etc., and do not include primary stresses which may also exist at the same point. It should be noted, however, that a detailed stress analysis frequently gives the combination of primary and secondary stresses directly and, when appropriate, this calculated value represents the total of $P_m$ for $P_L + P_b + Q$ and not $Q$ alone. Similarly, if the stress in category $F$ is produced by a stress concentration, the quantity $F$ is the additional stress produced by the notch, over and above the nominal stress. For example, if a plate has a nominal stress intensity $S$ and has a notch with a stress concentration factor $K$, then $P_m = S$, $P_b = 0$, $Q = 0$, $F = P_m (K-1)$, and the peak stress intensity equals $P_m + P_m (K-1) = KP_m$.

(3) This limitation applies to the range of stress intensity. When the secondary stress is due to a temperature excursion at the point at which the stresses are being analyzed, the value of $S_m$ shall be taken as the average of the $S_m$ values tabulated in Section II, Part D, Subpart 1, Tables 2A and 2B for the highest and lowest temperature of the metal during the transient. When part or all of the secondary stress is due to mechanical load, the value of $S_m$ shall be taken as the $S_m$ value for the highest temperature of the metal during the transient.

(4) Values shown are applicable when $P_L \leq 0.67 S_m$. When $P_L > 0.67 S_m$, use $(2.5 - 1.5 (D_L / S_m)) (K S_m)$. This relationship applies only to Service Level C.

(5) $S_m$ is obtained from the fatigue curves (Figs. XIV-1221.3(c)-1, XIV-1221.3(c)-2, and XIV-1221.3(c)-3). The allowable stress intensity for the full range of fluctuation is $2S_m$.