(b) The maximum primary shear, experienced as a result of Design Loadings, Test Loadings, or any Service Loadings except those for which Level D Limits are designated, exclusive of stress concentration at the periphery of a solid circular section in torsion, shall be limited to 0.8 $S_m$.

(c) Primary plus secondary shear stresses shall be considered as such stresses permitted in the design criteria are such that the maximum stress calculated on an elastic basis may exceed the yield strength of the material.

NF-3223.3 Triaxial Stresses. The algebraic sum of the three primary principal stresses ($1 + 2 + 3$) shall not exceed four times the tabulated value of $S_m$.

NF-3223.4 Applications of Elastic Analysis for Stresses Beyond the Yield Strength. Certain of the allowable stresses permitted in the design criteria are such that the maximum stress calculated on an elastic basis may exceed the yield strength of the material.

NF-3224 Design Stress Values

The design stress intensity values $S_m$ are given in Section II, Part D, Subpart 1, Tables 2A, 2B, and 4 for support material. Values for intermediate temperatures may be found by interpolation. Values of yield strength and ultimate tensile strength are given in Section II, Part D, Subpart 1, Tables Y-1 and U, respectively. Values of the coefficients of thermal expansion and of the modulus of elasticity are given in Section II, Part D, Subpart 2, Tables TE and TM.

NF-3225 Design of Bolting

NF-3225.1 Design Limits. The rules and stress limits that must be satisfied for any Design Loading stated in the Design Specification are those given in NF-3324.6.

NF-3225.2 Service Limits, Level A Through D. The rules and stress limits which must be satisfied for any Level A through D Service Loading stated in the Design Specification are those given in NF-3324.6 multiplied by the appropriate stress limit factor for the particular service loading level and stress category specified in Table NF-3225.2-1. This product shall not exceed the yield strength of the material at temperature.

NF-3225.3 Test Limits. The rules and stress limits that must be satisfied for any Test Loadings stated in the Design Specification are those given in NF-3324.6 multiplied by the appropriate stress limit factor for the particular Service Loading Level and stress category specified in Table NF-3225.2-1.

NF-3225.4 Friction-Type Joints. Multiplying factors normally used to increase the allowable limits for Service Level B, C, and D are not applicable to friction type joints [see NF-3324.6(a)(4)].

NF-3226 Design of Welded Joints

NF-3226.1 Permissible Types of Welded Joints in Plate- and Shell-Type Supports. All welded joints in Plate- and Shell-Type Supports shall be continuous and shall be of one of the types listed in (a) through (c). Typical examples of those permitted types are shown in Figure NF-3226.1-1. Fillet and partial penetration welds shall meet the requirements of NF-3324.5(d), except that NF-3324.5(d)(7) does not apply.

(a) Butt Joints. Butt joints shall be one of the following:

1. full penetration, single or double welded [Figure NF-3226.1-1, sketches (a1) and (a2)]

2. partial penetration, double welded [Figure NF-3226.1-1, sketch (b)]

(b) the applicable welds may be either square groove, V groove, bevel groove, J groove, U groove, flare V groove, or flare bevel groove [see Figure NF-3226.1(a)-1].

4. when angle joints are used for connecting a transition in diameter to a cylinder, the angle of Figure NF-3226.1-1, sketch (f) shall not exceed 30 deg.

4. A tapered transition having a length not less than three times the offset between the adjacent surfaces of abutting sections, as shown in Figure NF-3226.1(a)-2 shall be provided at joints between sections that differ in thickness by more than one-fourth of the thickness of the thinner section or by more than $\frac{7}{8}$ in. (3 mm), whichever is less. The transition may be formed by any process.

Notes (1), (2)

<p>| Table NF-3225.2-1 Stress Limit Factors for Class 1, 2, 3, and MC Bolt Design by Analysis |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Stress Category</th>
<th>Design</th>
<th>Service Level A</th>
<th>Service Level B</th>
<th>Service Level C</th>
<th>Service Level D</th>
<th>Test Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension and shear</td>
<td>$K_{bs} = 1.0$</td>
<td>$K_{bs} = 1.0$</td>
<td>$K_{bs} = 1.15$</td>
<td>$K_{bs} = 1.25$</td>
<td>$K_{bs} = 1.5$</td>
<td>$K_{bs} = 1.25$</td>
</tr>
</tbody>
</table>

GENERAL NOTE: $K_{bs} =$ stress limit factor applicable to the Design allowable tensile and shear stresses

NOTES:
(1) Not to be used for friction type connections.
(2) Average tensile stress shall not exceed 0.7 $S_y$ and $S_y$, and average bolt shear stress shall not exceed 0.42 $S_y$ and 0.6 $S_y$. 

10/10/2019 Informational note - corrected spacing in Note (2) so it prints properly
(9) Fillet Welds in Holes and Slots. Fillet welds in holes or slots may be used to transmit shear in lap joints or to prevent the buckling or separation of lapped parts and to join elements of built-up members. Such fillet welds may overlap, subject to the provisions of (6). Fillet welds in holes or slots are not to be considered plug or slot welds.

(10) Use of Plug and Slot Welds. Plug and slot welds may be used to transmit shear in a lap joint or to prevent buckling of lapped parts and to join component parts of built-up members.

(11) Diameter of Holes for Plug Welds. The diameter of the holes for a plug weld shall be not less than the thickness of the part containing it plus \( \frac{5}{16} \) in. (8 mm), rounded to the next greater odd \( \frac{5}{16} \) in. (1.5 mm), nor greater than the minimum diameter plus \( \frac{5}{8} \) in. (3 mm) or \( 2\frac{3}{4} \) times the thickness of the weld metal.

(12) Spacing of Plug Welds. The minimum center-to-center spacing of plug welds shall be four times the diameter of the hole.

(13) Length of Slot Welds. The length of slot for a slot weld shall not exceed 10 times the thickness of the part containing it plus \( \frac{5}{16} \) in. (8 mm), rounded to the next greater odd \( \frac{5}{16} \) in. (1.5 mm), nor greater than the thickness of the part plus \( \frac{5}{8} \) in. (3 mm) or \( 2\frac{3}{4} \) times the thickness of the weld metal.

(14) Spacing of Slot Welds. The minimum spacing of lines of slot welds in a direction transverse to their length shall be four times the width of the slot. The minimum center to center spacing in a longitudinal direction on any line shall be two times the length of the slot.

(15) Thickness of Plug and Slot Welds. The thickness of plug and slot welds in material \( \frac{5}{16} \) in. (16 mm) or less in thickness shall be equal to the thickness of the material. In material over \( \frac{5}{8} \) in. (16 mm) in thickness, it shall be at least one-half the thickness of the material but not less than \( \frac{5}{8} \) in. (16 mm).

(16) Effective Shearing Area of Plug and Slot Welds. The effective shearing area of plug and slot welds shall be considered as the nominal cross-sectional area of the hole or slot in the plane of the faying surface.

(17) Full Penetration and Partial Penetration Joints. The effective area shall be the effective weld length multiplied by the effective throat thickness.

(1) The effective weld length for any groove weld, square or skewed, shall be the length of weld throughout which the correct proportioned cross section exists. In a curved weld it shall be its true length measured along its curvature.

(2) The effective throat thickness of a full penetration groove weld which shall conform to the requirements of

(18) The effective throat of partial penetration groove welds is dependent upon the type of groove.

(a) For square, U, and J groove welds, the effective throat is equal to the depth of preparations.

(b) For V and bevel groove welds with an included angle at the root equal to or greater than 60 deg, the effective throat shall be the minimum distance from the root to the face of the weld.

(c) For V and bevel groove welds with an included angle at the root less than 60 deg but equal to or greater than 45 deg, the effective throat shall be the minimum distance from the root to the face of the weld less \( \frac{5}{8} \) in. (3 mm).

(d) For V and bevel groove welds, with an included angle at the root less than 45 deg but equal to or greater than 30 deg, the effective throat shall be the minimum distance from the root to the face of the weld less \( \frac{5}{8} \) in. (3 mm) and multiplied by 0.75. The required effective throat must be specified on the drawing.

(e) For V and bevel groove welds, angles less than 30 deg at the root are not allowed.

(f) For flare bevel groove welds, when filled flush to the surface, the effective throat shall be \( 0.31 \) times the outside radius of the curved section forming the groove. For formed rectangular tubing, the outside radius may be considered as two times the wall thickness.

(g) For flare V groove welds, when filled flush to the surface, the effective throat shall be \( 0.5 \) [except use 0.375 for GMAW when \( R \geq \frac{1}{2} \) in. (13 mm)] times the outside radius.

(h) Consideration of Lamellar Tearing. Welded joint configurations causing significant through-thickness tensile stress [as defined in NF-1215(b)] during fabrication and/or service on rolled product forms should be avoided. However, if this type of construction is used, the designer should consider one or several of the following factors that may reduce the susceptibility of the joint to experience lamellar tearing and provide documentation, including fabrication requirements, in the Design Output Documents:

(1) Reduce volume of weld metal to the extent practical.

(2) Select materials that are resistant to lamellar tearing.

(3) Invoke any of the special fabrication requirements of NF-4441.

NF-3324.6 Design Requirements for Bolted Joints. The rules and stress limits for bolting shall be as given in this paragraph. The stress limits which must be satisfied for any Design, Levels A through D, and Test Loadings, shall be those given in this paragraph, multiplied by the appropriate stress limit factors given in Table NF-3225.2-1 for the particular Loading specified in the Design Specification (NCA-3250). This product shall not exceed the yield strength of the material at temperature.