stresses in shells, hemispherical heads, and tubular products are given in Appendix VII.

**NG-3133.2 Nomenclature.** The symbols used in this paragraph are defined as follows:

- **A** = factor determined from Fig. G, Section II, Part D, Subpart 3 and used to enter the applicable material chart in Section II, Part D, Subpart 3. For the case of cylinders having \( D_o/T \) values less than 10, see NG-3133.3(b). Also, factor determined from the applicable chart in Section II, Part D, Subpart 3 for the material used in a stiffening ring, corresponding to the factor \( B \) and the design metal temperature for the shell under consideration.

- **A_s** = cross-sectional area of a stiffening ring

- **B** = factor determined from the applicable chart in Section II, Part D, Subpart 3 for the material used in a shell or stiffening ring at the design metal temperature

- **D_o** = outside diameter of the cylindrical shell course or tube under consideration

- **E** = modulus of elasticity of material at Design Temperature (for this value, see Table TM, Section II, Part D, Subpart 2). Use the curve with this value on the material/temperature line of the applicable chart in Section II, Part D, Subpart 3.

- **I** = available moment of inertia of the combined ring–shell section about its neutral axis, parallel to the axis of the shell, in.\(^4\) (mm\(^4\)). The width of the shell which is taken as contributing to the combined moment of inertia shall not be greater than 1.10 \( \sqrt{D_o/T} \), and shall be taken as lying one-half on each side of the centroid of the ring. Portions of shell plates shall not be considered as contributing area to more than one stiffening ring.

- **I_s** = required moment of inertia of the combined ring–shell section about its neutral axis parallel to the axis of the shell

- **L** = total length of a tube between tubesheets, or the design length of a cylindrical section, taken as the largest of the following:
  1. the distance between head tangent lines plus one-third of the depth of each head if there are no stiffening rings
  2. the greatest center-to-center distance between any two adjacent stiffening rings or
  3. the distance from the center of the first stiffening ring to the head tangent line plus one-third of the depth of the head, all measured parallel to the axis of the cylinder, in. (mm)

- **L_s** = one-half of the distance from the center line of the stiffening ring to the next line of support on one side, plus one-half of the center line distance to the next line of support on the other side of the stiffening ring, both measured parallel to the axis of the component. A line of support is
  1. a stiffening ring that meets the requirements of this paragraph
  2. a circumferential line on a head at one-third the depth of the head from the head tangent line or
  3. a circumferential connection to a jacket for a jacketed section of a cylindrical shell

- **P** = external design pressure (gage or absolute, as required)

- **P_T** = allowable external pressure (gage or absolute, as required)

- **R** = inside radius of spherical shell

- **S** = the lesser of 1.5 times the stress intensity at design metal temperature from Tables 2A and 2B, Section II, Part D, Subpart 1 or 0.9 times the tabulated yield strength at design metal temperature from Tables Y-1, Section II, Part D, Subpart 2

- **T** = minimum required thickness of cylindrical shell or tube, or spherical shell

- **T_n** = nominal thickness used, less corrosion allowance, of a cylindrical shell or tube

**NG-3133.3 Cylindrical Shells and Tubular Products**

(a) The minimum thickness of cylindrical shells or tubular products under external pressure difference having \( D_o/T \) values equal to or greater than 10 shall be determined by the procedure given in Steps 1 through 8.

**Step 1:** Assume a value for \( T \). Determine the ratios \( L/D_o \) and \( D_o/T \).

**Step 2:** Enter Fig. G, Section II, Part D, Subpart 3 at the value of \( L/D_o \) determined in Step 1. For values of \( L/D_o \) greater than 50, enter the chart at a value of \( L/D_o \), of 50. For values of \( L/D_o \), less than 0.05, enter the chart at a value of \( L/D_o \) of 0.05.

**Step 3:** Move horizontally to the line for the value of \( D_o/T \) determined in Step 1. Interpolation may be made for intermediate values of \( D_o/T \). From this intersection move vertically downwards and read the value of factor \( A \).

**Step 4:** Using the value of \( A \) calculated in Step 3, enter the applicable material chart in Section II, Part D, Subpart 3 for the material/temperature under consideration. Move vertically to an intersection with the material/temperature line for the Design Temperature. Interpolation may be made between lines for intermediate temperatures. In cases where the value of \( A \) falls to the right of the end of the material/temperature line, assume an intersection with the horizontal projection of the upper end of the material/temperature line. For values of \( A \) falling to the left of the material line, see Step 7.

**Step 5:** From the intersection obtained in Step 4 move horizontally to the right and read the value of \( B \).
SECTION III, DIVISIONS 1 AND 2 — INTERPRETATIONS VOL. 60

Interpretation: III-1-10-03

Subject: Section III, Division 1, NG-3234, Level C Service Limits for Threaded Structural Fasteners

Date Issued: August 20, 2009

File: 09-786

Question: Should only the stress limits of NG-3232 (NG-3232.1 and NG-3223.2) be applicable to high-strength fasteners (specified minimum $S_u \geq 100$ ksi) under Level C service conditions?

Reply: Yes.

Interpretation: III-1-10-04

Subject: Section III, Division 1, NG-3234, Level C Service Limits for Threaded Structural Fasteners

Date Issued: August 20, 2009

File: 09-1291

Question: May special processes (such as stress improvement techniques) that are not specifically addressed in Section III be performed under the rules of Section III construction?

Reply: Yes, provided the controls of NCA-4134.9 and the Code are met.

Interpretation: III-1-10-05

Subject: Section III, Division 1, NCA-3689, Certificate of Compliance

Date Issued: August 20, 2009

File: 09-1293

Question (1): Are there any limitations on the dimensions of materials that are listed on the Certificate of Compliance for nonwelded supports?

Reply (1): No.

Question (2): When a support manufacturer transmits copies of the material Certificates of Compliance applicable to each support as permitted by NF-2130(d), is a support Certificate of Compliance also required to be submitted by the NS certificate holder?

Reply (2): Yes.