(c) **Service Conditions.** The provisions of NC-3113 shall apply.

(d) **Test Pressure.** The test pressure is the pressure to be applied at the top of the vessel during the test. This pressure plus any pressure due to static head at any point under consideration is used in the applicable equation to check the vessel under test conditions.

(e) **Safety Valve Setting.** The pressure for which the safety or safety relief valves are set to open is established by Article NC-7000.

### NC-3216 Design Stress Intensity Values

#### NC-3216.1 Stress Tables.** The design stress intensity values $S_m$ are given in Section II, Part D, Subpart 1, Tables 2A, 2B, and 4. Values for intermediate temperatures may be found by interpolation. These $S_m$ values form the basis for the various stress limits which are described in Section III Appendices, Mandatory Appendix XIII and are used in determining the membrane stress intensity limits for the various load combinations given in Table NC-3217-1.

#### NC-3216.2 Coefficients of Thermal Expansion and Moduli of Elasticity.** Values of the coefficients of thermal expansion are in Section II, Part D, Subpart 2, Tables TE, and values of the moduli of elasticity are in Section II, Part D, Subpart 2, Tables TM.

#### NC-3216.3 Special Stress Limits.** The deviations given in (a), (b), and (c) below from the basic stress limits are provided to cover special conditions or configurations.

(a) **Bearing Loads**

(1) The average bearing stress for resistance to crushing under the maximum design load shall be limited to the yield strength $S_y$ at temperature except that, when the distance to a free edge is greater than the distance over which the bearing load is applied, a stress of $1.5S_y$ at temperature is permitted. For clad surfaces, the yield strength of the base metal may be used if, when calculating the bearing stress, the bearing area is taken as the lesser of the actual contact area or the area of the base metal supporting the contact surface.
\( \sigma_b \) = bending stress. This stress is equal to the linear varying portion of the stress across the solid section under consideration. It includes discontinuities and concentrations and is produced only by pressure and other mechanical loads.

\( \sigma_L \) = local membrane stress. This stress is the same as \( \sigma_m \), except that it includes the effect of discontinuities.

\( \sigma_m \) = general membrane stress. This stress is equal to the average stress across the solid section under consideration. It excludes discontinuities and concentrations and is produced only by pressure and other mechanical loads.

Typical examples of locations for which \( \sigma_b, \sigma_L, \) and \( \sigma_m \) are applicable are shown in Table NC-3321-2.

NC-3322 Special Considerations

The provisions of NC-3120 apply.

NC-3323 General Design Rules

The provisions of NC-3130 apply except as modified by the rules of this subarticle. In case of conflict, this subarticle governs the design of vessels.

NC-3324 Vessels Under Internal Pressure

NC-3324.1 General Requirements. Equations are given for determining the minimum thicknesses under internal pressure loading in cylindrical and spherical shells and ellipsoidal, torispherical, toriconical, conical, and hemispherical heads. Provision shall be made for any of the other loadings listed in NC-3111 when such loadings are specified.

| Table NC-3321-1 |
|-----------------|-----------------|
| **Stress Limits for Design and Service Loadings** |
| Service Limit | Stress Limits [Note (1)] |
| Design and Level A | \( \sigma_m \leq 1.0S \) |
| | \( (\sigma_m \text{ or } \sigma_L) + \sigma_b \leq 1.5S \) |
| Level B | \( \sigma_m \leq 1.10S \) |
| | \( (\sigma_m \text{ or } \sigma_L) + \sigma_b \leq 1.65S \) |
| Level C | \( \sigma_m \leq 1.5S \) |
| | \( (\sigma_m \text{ or } \sigma_L) + \sigma_b \leq 1.8S \) |
| Level D | \( \sigma_m \leq 2.0S \) |
| | \( (\sigma_m \text{ or } \sigma_L) + \sigma_b \leq 2.4S \) |

GENERAL NOTE: See NC-3321.1 for definitions of symbols.

NOTE: (1) These limits do not take into account either local or general buckling that might occur in thin-wall vessels.

NC-3324.2 Nomenclature. The symbols used in this paragraph and Figure NC-3324.2-1 are defined as follows:

\( D \) = inside diameter of the head skirt; inside length of the major axis of an ellipsoidal head; or inside diameter of a conical head at the point under consideration, measured perpendicular to the longitudinal axis

\( D_o \) = outside diameter of the head skirt; outside length of the major axis of an ellipsoidal head; or outside diameter of a conical head at the point under consideration, measured perpendicular to the longitudinal axis

\( D_1 \) = inside diameter of the conical portion of a toriconical head at its point of tangency to the knuckle, measured perpendicular to the axis of the cone

\( D/2h \) = ratio of the major to the minor axis of ellipsoidal heads, which equals the inside diameter of the skirt of the head divided by twice the inside height of the head and is used in Table NC-3324.2-1

\( h \) = one-half of the length of the minor axis of the ellipsoidal head or the inside depth of the ellipsoidal head measured from the tangent line, head bend line

\( K \) = a factor in the equations for ellipsoidal heads depending on the head proportion, \( D/2h \) (Table NC-3324.2-1)

\( L \) = inside spherical or crown radius for torispherical and hemispherical heads

\( L_o \) = outside spherical or crown radius

\( P \) = Design Pressure

\( R \) = inside radius of the shell course under consideration before corrosion allowance is added

\( r \) = inside knuckle radius

\( R_o \) = outside radius of the shell course under consideration

\( S \) = maximum allowable stress value (Section II, Part D, Subpart 1, Tables 1A, 1B, and 3)

\( t \) = minimum required thickness of shell or head after forming, exclusive of corrosion allowance

\( \alpha \) = one-half of the included apex angle of the cone at the centerline of the head

For Information only: Editors advised that NC-3321.1 does not exist. The definitions in question are located in NC-3321.