(1) For components subjected to internal pressure difference, the inside diameter shall be taken at the nominal inner face of the cladding.

(2) For components subjected to external pressure difference, the outside diameter shall be taken at the outer face of the base metal.

(c) Deformation-Controlled Quantities. No structural strength shall be attributed to the cladding in satisfying requirements on buckling instability. However, the cladding shall be considered in all other calculations related to satisfying limits on deformation-controlled quantities.

(d) Bearing Stresses. In satisfying (a), the presence of cladding shall be included.

HGB-3230 STRESS LIMITS FOR LOAD CONTROLLED STRESSES IN THREADED STRUCTURAL FASTENERS

HGB-3231 General Requirements

(a) The rules of this paragraph apply to mechanical connections joining parts in core support structures located within a pressure retaining boundary. Devices that are used to assemble structural elements of core support structures are referred to as threaded structural fasteners. The design stress intensity values $S_{out}$ for threaded structural fasteners shall be the values given in Tables 1-14.3A through I-1-14.3E of Division 1, Subsection NH.

(b) The special stress limits of HGB-3227 do not apply to threaded structural fasteners.

(c) For connections joining parts of pressure retaining boundaries, the rules for Class A components in elevated temperature service (Subsection HB, Subpart B) shall apply.

HGB-3232 Design and Level A Service Limits

The number and cross-sectional area of threaded structural fasteners shall be such that the stress intensity limits of this paragraph are satisfied for the Design Loadings and for the Service Loadings for which Level A Limits are designated in the Design Specifications. Any deformation limit prescribed in the Design Specifications shall be considered. The total axial load transferred through the fastener threads shall not go to or through zero during the specified Service Loadings.

HGB-3232.1 Average Stress. Elastic analysis of specified conditions shall show the following:

(a) The maximum value of the primary membrane stress due to internal pressure difference and other mechanical loads (excluding stresses from preload), averaged across either the area of the fastener shank or the tensile area of the threads, shall be no greater than either:

\[
1.0S_{out} \quad \text{or}
\]

\[
2.0S_{out}^{2} \quad \text{provided the strains and deformations, including the effects of ratcheting, creep, and eventual retightening, are evaluated and shown to be acceptable per HGB-3250, and;}
\]

(b) The maximum value of the primary plus secondary membrane stress including stress from preload meets the requirements of (1) and (2) below.

(1) The maximum value of the membrane stress averaged across either the area of the fastener shank or the stress area of the threads, and neglecting stress concentrations, shall be no greater than $S_{out}$ for the design life at the maximum service temperature, unless the design lifetime is divided into two or more loading periods and the possibility of creep rupture due to membrane stresses is guarded against by satisfying the use-fraction rule described in HGB-3224(b) with the use-fraction factor, $B$, set equal to $0.5^{0.25}$. Stress intensity, rather than maximum stress, shall be limited to this value when threaded structural fasteners are

(a) tightened by devices that result in residual torsion stresses (residual torsion stresses are minimized by devices such as heaters and stretchers)

(b) loaded in transverse shear, or

(c) both

(2) If a tight joint is required, the stress due to preload shall be shown to remain greater than that due to primary and secondary membrane stress excluding preload, throughout the design life of the joint.

HGB-3232.2 Maximum Stress. The maximum value of the primary membrane and bending plus secondary membrane and bending stresses produced by the combination of all primary loads and secondary loads but excluding effects of stress concentrations shall not exceed the lesser of $1.5S_{out}$ or $K_{p}S_{p}$ for the design life at the maximum service temperature, unless the design lifetime is divided into two or more loading periods and the possibility of creep rupture due to bending stresses is guarded against by satisfying the use-fraction rule described in HGB-3224(d) but with the use-fraction set at 0.67 instead of $1.0^{0.25}$. Stress intensity, rather than maximum stress, shall be limited to this value when threaded structural fasteners are

(a) tightened by devices that result in residual torsion stresses (residual torsion stresses are minimized by devices such as heaters and stretchers)

(b) loaded in transverse shear, or

(c) both

HGB-3232.3 Nonductile Fracture. The rules of HGB-3241 shall apply to threaded structural fasteners.
(-a) a low yield-strength-to-ultimate-tensile-strength ratio  
(-b) a high uniform elongation value  
(-c) a cross section that can distort under load in a manner that reduces the moment of inertia or that increases the loading on the structure  

(c) The rest of the fatigue evaluation stays the same as required in HGB-II-3222.4 of this Appendix, except that the procedure of Division 1, NG-3227.6 need not be used.  
(d) The structure meets the thermal ratcheting requirement of Division 1, NG-3222.5.  
(e) The material shall have a specified minimum yield strength to specified minimum tensile strength ratio of less than 0.80.

HGB-II-3229 Design Stress Values

The design stress intensity values $S_m$ are given in Tables 2A and 2B, Section II, Part D, Subpart 1 for core support structure material. Values for intermediate temperatures may be found by interpolation. These form the basis for the various stress limits. Values of yield strength are given in Table Y-1, Section II, Part D, Subpart 1. Values of the coefficient of thermal expansion are in Table TE, Section II, Part D, Subpart 2, and values of the modulus of elasticity are in Table TM, Section II, Part D, Subpart 2. The basis for establishing stress intensity values is given in Section II, Part D, Mandatory Appendix 2. The design fatigue curves used in conjunction with Division 1, NG-3222.4 are those of Division 1 Appendices, Figs. I-9.1 through I-9.7 (and the extended fatigue curves from Tables HGB-II-3222.4-1 through HGB-II-3222.4-4).

The design stress intensity values in Tables 2A and 2B of Section II, Part D, Subpart 1 may be extended to elevated temperatures using the values in Tables HGB-II-2121-1 and HGB-II-2121-3 of this Appendix, provided the time-temperature requirements of Mandatory Appendix HGB-IV are satisfied, and the materials of construction meet the requirements of the specifications given in Tables HGB-II-2121-1 and HGB-II-2121-3 of this Appendix. The yield strength values of Table Y-1 of Section II, Part D, Subpart 1 may be extended to elevated temperatures using the values in Tables HGB-II-3229-1 and HGB-II-3229-3 of this Appendix. In evaluating the functional adequacy of the core support structure, the N Certificate Holder shall account for the plastic strain that is associated with the $S_m$ limits for materials to which Note (3) of Table HGB-II-2121-3 applies. For elevated temperatures, the extended elevated temperature $S_m$ values are obtained from Tables HGB-II-3229-4 and HGB-II-3229-6 of this Appendix.

(a) The rules of this paragraph apply to mechanical connections joining parts in core support structures located within a pressure retaining boundary. Devices
TABLE HGB-III-2000-1
TIME-DEPENDENT BUCKLING LIMITS

<table>
<thead>
<tr>
<th>Load Factor [Note (1)]</th>
<th>Strain Factor [Notes (1), (2), (3)]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Limits</strong></td>
<td>3.00</td>
</tr>
<tr>
<td><strong>Service Level Limits</strong></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3.00</td>
</tr>
<tr>
<td>B</td>
<td>3.00</td>
</tr>
<tr>
<td>C</td>
<td>2.00</td>
</tr>
<tr>
<td>D</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**NOTES:**

(1) \[
\frac{\text{Load (or Strain) Factor}}{} = \frac{\text{Load (or strain) that would cause instant instability at the actual design or service temperature.}}{\text{Design or expected load (or strain) [Note (4)]}}
\]

(2) Changes in configuration induced by service need not be considered in calculating the buckling load.

(3) For thermally induced strain-controlled buckling, the Strain Factor is applied to loads induced by thermal strain. To determine the buckling strain, it may be necessary to artificially induce high strains concurrent with the use of realistic stiffness properties. The use of an "adjusted" thermal expansion coefficient is one technique for enhancing the applied strains without affecting the associated stiffness characteristics.

(4) In this case, the strain represents the average membrane strain through the thickness.