APPENDIX 2
BASIS FOR ESTABLISHING DESIGN STRESS INTENSITY VALUES FOR TABLES 2A, 2B, 3, AND 4

2-100 DERIVATION OF STRESS INTENSITY VALUES

In the determination of design stress intensity values for nonnuclear materials, the Committee is guided by successful experience in service, insofar as evidence of satisfactory performance is available. Such evidence is considered equivalent to test data where operating conditions are known with reasonable certainty. In the evaluation of new materials for both nuclear and nonnuclear applications, it is sometimes necessary to be guided to a certain extent by the comparison of test information with available data on successful applications of similar materials.

The factors employed to determine design stress intensity values are provided in Tables 2-100(a), 2-100(b), and 2-100(c). Nomenclature for these Tables is as follows:

F_{avg} = multiplier applied to average stress for rupture in 100,000 hr. At 1500°F and below, $F_{avg} = 0.67$. Above 1500°F, it is determined from the slope of the log time-to-rupture versus log stress plot at 100,000 hr such that $\log F_{avg} = 1/n$, but it may not exceed 0.67.

R_T = ratio of the average temperature dependent trend curve value of tensile strength to the room temperature tensile strength

R_Y = ratio of the average temperature dependent trend curve value of yield strength to the room temperature yield strength

S_T = specified minimum tensile strength at room temperature, ksi

S_Y = specified minimum yield strength at room temperature, ksi

n = a negative number equal to Δ log time-to-rupture divided by Δ log stress at 100,000 hr

NA = not applicable

The maximum design stress intensity shall be the lowest value obtained from the criteria in Tables 2-100(a), 2-100(b), and 2-100(c). The mechanical properties considered, and the factors applied to establish the maximum allowable stresses, are given in 2-110 through 2-130.

2-110 CRITERIA FOR MATERIALS OTHER THAN BOLTING: TABLES 2A AND 2B

The design stress intensity values at any temperature are no larger than the least of the following:

(a) one-third of the specified minimum tensile strength at room temperature;

(b) one-third of the tensile strength at temperature;

(c) two-thirds of the specified minimum yield strength at room temperature;

(d) two-thirds of the yield strength at temperature, except that for austenitic stainless steels and specific nonferrous materials, as indicated in Tables 2A and 2B, this value may be as large as 90% of the yield strength at temperature (but never more than two-thirds of the specified minimum yield strength).

(e) In the application of these criteria, the Committee considers the yield strength at temperature to be $S_Y R_Y$, and the tensile strength at temperature to be $1.1 S_T R_T$.

2-120 CRITERIA FOR BOLTING MATERIALS IN TABLE 3 FOR USE WITH SECTION VIII, DIVISION 1; SECTION VIII, DIVISION 2 (APPENDIX 3 RULES); AND SECTION III (CLASS 2 AND 3 RULES)

(a) For materials whose strength has not been enhanced by heat treatment or by strain hardening, the

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TABLE 2-100(a)
CRITERIA FOR ESTABLISHING DESIGN STRESS INTENSITY VALUES FOR TABLES 2A AND 2B

Product/Material	Tensile Strength		Yield Strength	
Wrought or cast, ferrous and nonferrous	$\frac{1}{3}\ S_T$	$\frac{1.1}{3}\ S_T R_T$	$\frac{2}{3}\ S_Y$	$\frac{2}{3}\ S_Y R_Y$ or $0.9 S_Y R_Y$ [Note (1)]
Welded pipe or tube, ferrous and nonferrous	$\frac{0.85}{3}\ S_T$	$\frac{(1.1 \times 0.85)}{3}\ S_T R_T$	$\frac{0.85}{1.5}\ S_Y$	$\frac{0.85}{1.5}\ S_Y R_Y$ or $(0.9 \times 0.85) S_Y R_Y$ [Note (1)]

NOTE:
(1) For austenitic materials in Table 2A and for specific nonferrous alloys in Table 2B, the design stress intensity values may exceed two-thirds and may be as high as 90% of the yield strength at temperature.

TABLE 2-100(b)
CRITERIA FOR ESTABLISHING ALLOWABLE STRESS VALUES FOR TABLE 3

	Below Room Temperature		Room Temperature and Above						
Product/Material	Tensile Strength	Yield Strength	Tensile Strength		Yield Strength		Stress Rupture		Creep Rate
Bolting annealed ferrous and nonferrous	$\frac{S_T}{4}$	$\frac{2}{3}\ S_Y$	$\frac{S_T}{4}$	$\frac{1.1}{4}\ S_T R_T$	$\frac{2}{3}\ S_Y$	$\frac{2}{3}\ S_Y R_Y$	$F_{avg} S_{R\,avg}$	$0.8 S_{R\,min}$	$1.0 S_c$
Bolting, with strength enhanced by heat treatment or strain hardening, ferrous and nonferrous [Note (1)]	$\frac{S_T}{5}$	$\frac{S_Y}{4}$	$\frac{1}{5}\ S_T$	$\frac{1.1}{4}\ S_T R_T$	$\frac{1}{4}\ S_Y$	$\frac{2}{3}\ S_Y R_Y$	$F_{avg} S_{R\,avg}$	$0.8 S_{R\,min}$	$1.0 S_c$

NOTE:
(1) For materials whose strength has been enhanced by heat treatment or by strain hardening, the criteria shown shall govern unless the values are lower than for the annealed material, in which case the annealed values shall be used.

TABLE 2-100(c)
CRITERIA FOR ESTABLISHING DESIGN STRESS INTENSITY VALUES FOR TABLE 4

Product/Material	Tensile Strength		Yield Strength	
Bolting, with strength enhanced by heat treatment or strain hardening [Note (1)]	NA	NA	$\frac{1}{3}\ S_Y$	$\frac{1}{3}\ S_Y R_Y$

NOTE:
(1) This applies only to ferrous materials for Section VIII, Division 2 application.

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design stress intensity value shown at any temperature in Table 3 is the least of the following:

(1) one-fourth of the specified minimum tensile strength at room temperature;

(2) one-fourth of the tensile strength at temperature;

(3) two-thirds of the specified minimum yield strength at room temperature;

(4) two-thirds of the yield strength at temperature.

(b) For materials whose strength has been enhanced by heat treatment or by strain hardening, the design stress intensity value shown at any temperature in Table 3 is the least of the following, unless these values are lower than the annealed values, in which case the annealed values shall be used:

(1) one-fifth of the specified minimum tensile strength at room temperature;

(2) one-fourth of the tensile strength at temperature;

(3) one-fourth of the specified minimum yield strength at room temperature;

(4) two-thirds of the yield strength at temperature.

(c) In the application of these criteria, the Committee considers the yield strength at temperature to be $S_Y R_Y$, and the tensile strength at temperature to be $1.1 S_T R_T$.

(d) At temperatures in the range where creep and stress rupture strength govern the selection of stresses, the maximum allowable stress value for all materials is established by the Committee not to exceed the lowest of the following:

(1) 100% of the average stress to produce a creep rate of 0.01%/1000 hr;

(2) $100F_{avg}$% of the average stress to cause rupture at the end of 100,000 hr;

(3) 80% of the minimum stress to cause rupture at the end of 100,000 hr.

Stress values for high temperatures are based, whenever possible, on representative uniaxial properties of the materials obtained under standard ASTM testing conditions or equivalent. The stress values are based on basic properties of the materials and no consideration is given for corrosive environment, for abnormal temperature and stress conditions, or for other design considerations.

2-130 CRITERIA FOR BOLTING MATERIALS FOR USE WITH APPENDICES 4, 5, AND 6 OF SECTION VIII, DIVISION 2 AND SECTION III, SUBSECTION NB

The design stress intensity value shown at any temperature in Table 4 is the least of the following, with credit being granted for enhancement of properties by heat treatment or by strain hardening:

(a) one-third of the specified minimum yield strength at room temperature;

(b) one-third of the yield strength at temperature.

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