102.3 Allowable Stress Values and Other Stress Limits for Piping Components

(a) Allowable stress values to be used for the design of power piping systems are given in the tables in Mandatory Appendix A, also referred to in this Code Section as the Allowable Stress Tables. These tables list allowable stress values for commonly used materials at temperatures appropriate to power piping installations. In every case the temperature is understood to be the metal temperature. Where applicable, weld joint efficiency factors and casting quality factors are included in the tabulated values. Thus, the tabulated values are values of $S$, $SE$, or $SF$, as applicable.

(b) Allowable stress values in shear shall not exceed 80% of the values determined in accordance with the rules of (a). Allowable stress values in bearing shall not exceed 160% of the determined values.

(c) The basis for establishing the allowable stress values in this Code Section are the same as those in ASME BPVC, Section II, Part D, Mandatory Appendix 1 and Mandatory Appendix 2, 2-120; except that allowable stresses for cast iron and ductile iron are in accordance with ASME BPVC, Section VIII, Division 1, Nonmandatory Appendix P for Tables UCI-23 and UCD-23, respectively.

(22) 102.3.2 Limits for Sustained Stresses and Displacement Stress Ranges

(1) Cyclic Displacement Stress Ranges. The calculated reference displacement stress range, $S_c$ (see paras. 104.8.3 and 119.6.4), shall not exceed the allowable stress range, $S_A$, calculated by eq. (1A)

$$S_A = f (1.25S_c + 0.25S_h)$$ (1A)

When $S_h$ is greater than $S_L$, the difference between them may be added to the term $0.25S_h$ in eq. (1A). In that case, the allowable stress range, $S_A$, is calculated by eq. (1B)

$$S_A = f (1.25S_c + 1.25S_h - S_L)$$ (1B)

where

$$f = \text{cyclic stress range factor}^4 \text{ for the total number of equivalent reference displacement stress range cycles, } N, \text{ determined from eq. (1C)}$$

$$f = 6/N^{0.2} \leq 1.0$$ (1C)

$N$ = total number of equivalent reference displacement stress range cycles expected during the service life of the piping. A minimum value for $f$ is 0.15, which results in an allowable displacement stress range for a total number of equivalent reference displacement stress range cycles greater than $10^8$ cycles.

$S_c$ = basic material allowable stress at the minimum metal temperature expected during the reference stress range cycle, $\text{psi (kPa)}$

$S_h$ = basic material allowable stress at the maximum metal temperature expected during the reference stress range cycle, $\text{psi (kPa)}$

In determining the basic material allowable stresses, $S_c$ and $S_h$, for welded pipe, the joint efficiency factor, $E$, need not be applied (see para. 102.4.3). The values of the allowable stresses from Mandatory Appendix A or as calculated per para. 123.1.2(b) may be divided by the joint efficiency factor given for that material. In determining the basic material allowable stresses for castings, the casting quality factor, $F$, shall be applied (see para. 102.4.6).

When considering more than a single displacement stress range, whether from thermal expansion or other cyclic conditions, each significant stress range shall be computed. The reference displacement stress range, $S_D$,

1. Applies to essentially noncorroded piping. Corrosion can sharply decrease cyclic life; therefore, corrosion-resistant materials should be considered where a large number of significant stress range cycles is anticipated. The designer is also cautioned that the fatigue life of materials operated at elevated temperatures may be reduced.

2. For materials with a minimum tensile strength of over 70 ksi (480 MPa), eqs. (1A) and (1B) shall be calculated using $S_c$ or $S_h$ values no greater than 20 ksi (140 MPa), unless otherwise justified.