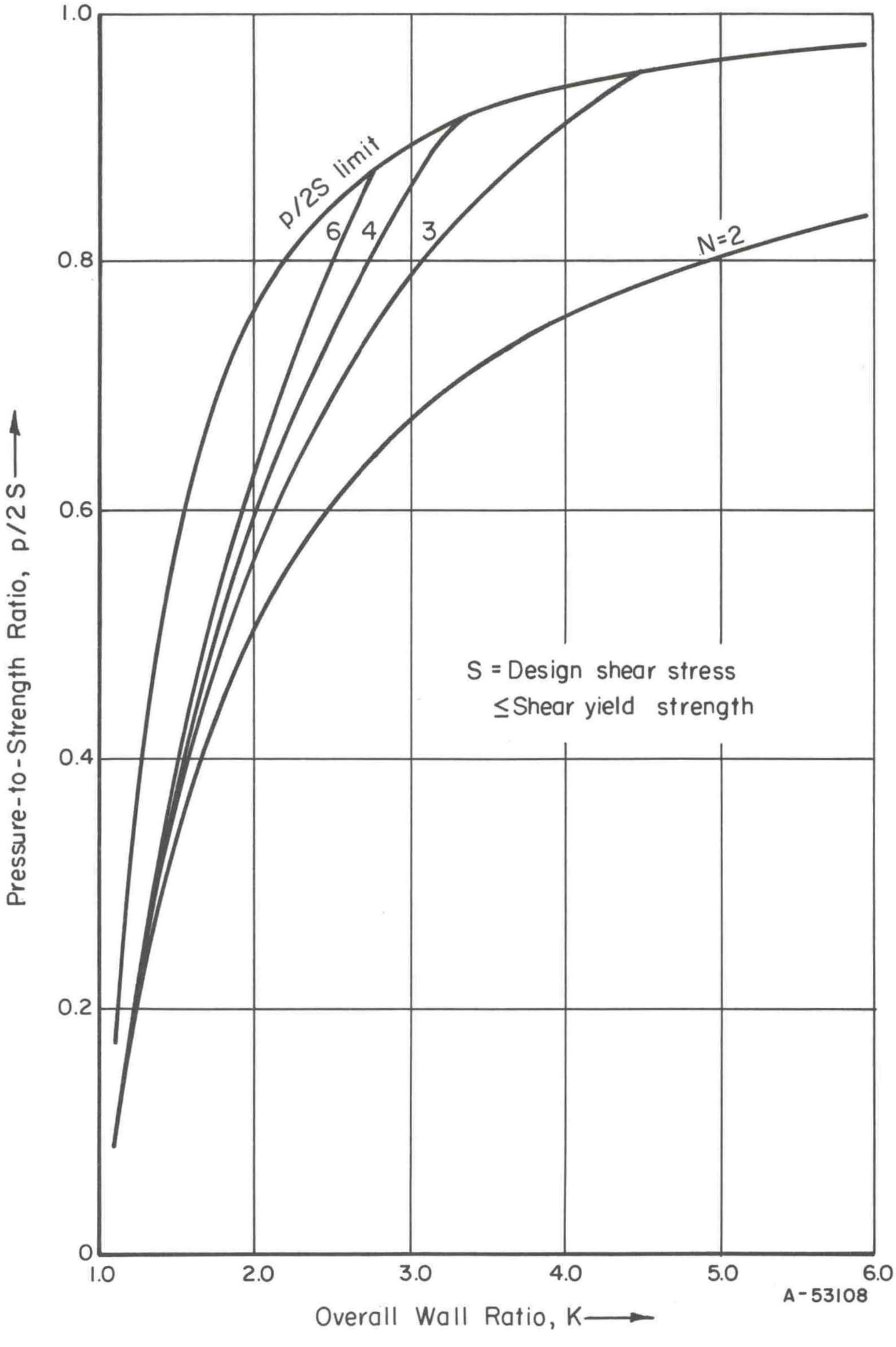

FIGURE 10. MAXIMUM PRESSURE-TO-STRENGTH RATIO, p/2S, IN MULTI-RING CONTAINER DESIGNED ON BASIS OF STATIC SHEAR STRENGTH

Each ring is assumed to be of the same ductile material.

The stresses S_r and S_m needed in expressing σ in Equation (12) are given by Equations (19) and (20).

The results of carrying out the analysis are:

$$p_n = p_{n-1} + \frac{p(k_n^2 - 1)}{4(K^2 - 1)} k_{n+1}^2 k_{n+2}^2 \ldots k_N^2 - \frac{\sigma(k_n^2 - 1)}{2k_n^2}, \; m = 1, 2, \ldots, N-1 \quad (41)$$

$$k_1 = k_2 \ldots = k_N \quad (42)$$

$$\sigma = \frac{5}{2N} p \frac{K^{2/N}}{K^{2/N} - 1} \quad (43)$$

The q_n are again given by Equation (35) and the resulting interference required is

$$\frac{\Delta_n}{r_n} = \frac{5p}{2NE} \quad (44)$$

The result p/σ is plotted in Figure 11. The limit curve is for $S_m = 0$ in the inner cylinder and is given by

$$\lim_{K \to \infty} \left(\frac{p}{\sigma}\right) = \lim_{K \to \infty} \left(\frac{2}{3} \frac{K^2 - 1}{K^2} \right) = \frac{2}{3} \quad (45)$$

If a ductile material has an ultimate tensile strength of 210,000 psi, then Equation (45) gives a maximum pressure of 140,000 psi based upon the shear fatigue criterion.

These results on ductile materials show that higher strength materials will have to be used in order to reach the high pressures desired. Accordingly, an analysis of a multi-ring container with a high-strength liner is now described.

High-Strength Liner Analysis

The hoop stress σ_θ at the bore of the liner undergoes the greatest range in stress during a cycle of pressure. Therefore, the tensile fatigue criterion is applied to the σ_θ stress. The range in the σ_θ stress at the bore of a multi-ring container depends only upon the over-all ratio K and the bore pressure p and is independent of the number of rings, i.e.,

$$(\sigma_\theta)_r = \frac{p}{2} \frac{K^2 + 1}{K^2 - 1} \quad (46)$$

(Equation (46) is found from Equation (16b) for $r = r_o$, $r_n = r_N$, and $k_n = K$.)