TABLE LII. SAFETY FACTORS ESTIMATED FOR THE COMPONENTS OF CONTAINER I FOR VARIOUS OPERATING CONDITIONS

Component	Type of Steel	Tensile Temperature, F	Tensile Yield Strength[a], psi	Shear Yield Strength[b], psi	Internal Pressure, psi	Effective Stress on Component[c], psi	Safety Factor[d]
Liner (ID)	AISI M50	80	330,000	190,000	250,000	162,250	1.17
		500	290,000	167,000	250,000	173,500	0.95
		80	330,000	190,000	230,000	144,000	1.32
		500	290,000	167,000	230,000	156,500	1.07
Sleeve (ID)	AISI H11	80	240,000	138,500	250,000	121,000	1.14
		500	215,000	124,000	250,000	106,250	1.17
		80	240,000	138,500	230,000	117,000	1.18
		500	215,000	124,000	230,000	104,250	1.19
Container (ID)	AISI 4340	80	160,000	92,300	250,000	47,250	1.95
		500	125,000	72,100	250,000	41,250	1.75
		500	125,000	72,100	230,000	40,750	1.77

(a) Estimated from measured hardnesses.

(b) Estimated as being 0.577 of tensile yield strength.

(c) Stress computed by Hencky-Von Mises relationship; shear stress by Tresca relationship would be approximately 2 to 6 percent lower.

(d) Based on ratio of shear yield strength to effective stress.

During the experimental research program the container assembly was operated approximately 12 times at 500 F and pressures up to 250,000 psi on the ram or stem. Based on experience at room temperature, the internal fluid pressures in those experiments are believed to have reached about 225,000 psi at the inside surface of the liner. The container was operated in approximately 350 experiments at room temperature. Fluid pressures inside the container ranged up to 265,000 psi. However, early in this program, the liner failed after holding at a fluid pressure of 246,000 psi (at 80 F) for 2-3/4 minutes. The failure consisted of a longitudinal crack that ran from the bottom of the liner to about 3-1/2 inches from the top and terminated in a transverse crack. At the time of failure, the stem was inserted about 4 inches into the liner bore. The longitudinal crack did not extend much beyond this point, evidently because of the high compressive prestresses on the bore above the stem seals.

The liner had been made from consumable, vacuum-melted AISI-M50 tool steel. Examination of the fractured surfaces of the liner by several techniques indicates that the failure resulted from low-cycle fatigue. The failure appears to have initiated at a point near the middle of the longitudinal crack. A photomacrograph at 25X of the fractured surface at the suspected point of initiation is shown in Figure 70. It is noted that radial markings appear to emanate from a small round void indicated by an arrow. This void is approximately 0.005 inch in diameter and is located about 0.008 inch beneath the liner bore surface. The mating fractured surface contains a protrusion which appears to match the void in size, shape, and location.

The precise nature of the protrusion is not known. It is suspected that it is an inclusion, although it is unusually large for consumable, vacuum-melted materials in which inclusions generally are no larger than about 0.0005 inch. This was found to be

25X 25674

FIGURE 70. FRACTOGRAPH OF FRACTURED SURFACE OF LINER OF CONTAINER I

Arrow points to void located about 0.008 inch beneath the linet bore surface.