of the study one of the crystals was intentionally heated to 935° K to test the possibility that either the transformation temperature may be higher than 935° K with single crystals and/or that the transformation does not destroy the sample, as is the case for titanium and zirconium [10]). After cooling, this crystal was polycrystalline and physically deformed, indicating that neither of the above suppositions is correct.

2.4. Limitations caused by attenuation

A complete set of data for determining all nine elastic stiffness moduli and the available cross checks, or internal consistency tests, at all temperatures required that the velocities of 18 different wave modes be measured at intervals of 10° to 20° between 298° K and 923° K. In fact, however, this schedule was not accomplished primarily because of acoustic energy losses within the uranium samples. These losses occurred for a majority of wave modes within temperature regions which varied in range and limits and did not appear significantly affected by frequency changes within the range of 30 mc/sec to 50 mc/sec. The losses were encountered in all samples, but only for certain wave modes and they occurred in reproducible temperature ranges during successive attempts to complete the measurements. In addition to these sample losses there occurred temperature and frequency dependent background losses caused by scattering of the acoustic waves within the buffer rods; consequently, it was not possible to measure the magnitude of the losses within the samples. The temperature ranges in which these losses prevented continuous measurements are given in table 1. The difficulties in measuring the shear mode velocities in crystal E above 300° K were apparently caused by a deformation kink produced during refacing the crystal after low temperature measurements were completed. The causes for the high attenuation above 325° K for both shear modes

Table 2

Equations used for evaluation of stiffness moduli

Modulus	Equation	Temperature range (°K)
c_{11}	Direct	298–923
c_{22}	(1) Direct	298–580, 650–850
	(2) $\dfrac{\varrho V^2_{\mathrm{F}} + \varrho V^2_{\mathrm{FS}} - c_{11}^2 \cos^2\theta_{\mathrm{F}} - c_{66}}{\sin^2\theta_{\mathrm{D}}}$	298–740, 860–923
c_{33}	Direct	298–923
c_{44}	(1) Direct, B	298–375
	(2) Direct, C	298–923
c_{55}	(1) Direct, A	298–600, 825-923
	(2) Direct, C	298–825
	(3) $\dfrac{\varrho V^2_{\mathrm{F}} - c_{44} \sin^2\theta_{\mathrm{F}}}{\cos^2\theta_{\mathrm{F}}}$	298–700, 823–923
	(4) $\varrho V^2_{\mathrm{D}} + \varrho V^2_{\mathrm{DS}} - c_{33} \cos^2\theta_{\mathrm{D}} - c_{11} \sin^2 \theta_{\mathrm{D}}$	298–750
c_{66}	(1) Direct, B	298–340
	(2) $\dfrac{\varrho V^2_{\mathrm{DPS}} - c_{44} \cos^2\theta_{\mathrm{D}}}{\sin^2\theta_{\mathrm{D}}}$	298–923
	(3) $\varrho V^2_{\mathrm{FL}} + \varrho V^2_{\mathrm{FS}} - c_{11} \cos^2\theta_{\mathrm{F}} - c_{22} \sin^2 \theta_{\mathrm{F}}$	298–580, 650–740, 860–923, from extrapolated c_{22}
c_{12}	(1) $f\,(\varrho V^2_{\mathrm{F}}, c_{11}, c_{22}, c_{66})$	298–923
	(2) $f\,(\varrho V^2_{\mathrm{FS}}, c_{11}, c_{22}, c_{66})$	298–740, 860–923
c_{13}	(1) $f\,(\varrho V^2_{\mathrm{D}}, c_{11}, c_{33}, c_{55})$	298–750
	(2) $f\,(\varrho V^2_{\mathrm{DS}}, c_{11}, c_{33}, c_{55})$	298–923
c_{23}	$f\,(\varrho V^2_{\mathrm{E}}, c_{33}, c_{22}, c_{44})$	298–923