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AEC Research and Development Report

HIGH-TEMPERATURE GRAPHITE
IRRADIATIONS: 550 TO 1450°C

JUNE 19, 1972

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Ceramics, Metals
and Materials

HIGH-TEMPERATURE GRAPHITE IRRADIATIONS:
550 to 1450 °C

By

W. C. Morgan and W. J. Gray

Ceramics and Graphite Section
Fuels and Materials Department

June 19, 1972

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HIGH-TEMPERATURE GRAPHITE IRRADIATIONS:
550 to 1450 °C

W. C. Morgan and W. J. Gray

ABSTRACT

Radiation-induced physical property and dimensional changes are presented on a wide variety of graphites irradiated at temperatures in the range from 550 to 1450 °C and to neutron fluences up to 2.25×10^{22} n/cm² (E > 0.18 MeV).

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INTRODUCTION

Installation of the H-1 capsule in the General Electric Test Reactor (GETR), during September 1959, marked the beginning of an extensive series of graphite irradiations at controlled temperatures. The experimental data, obtained on graphite samples irradiated in 40 separate controlled temperature capsules during the period from September 1959 to July 1967, has been reported previously by Helm.⁽¹⁾ That document covered the irradiation data on 58 types of graphites, irradiated at temperatures from 300 to 1200 °C and to neutron fluences up to 2.7×10^{22} n/cm² (E > 0.18 MeV).

In the last five years, the graphite irradiation program has been extended to obtain data at higher temperatures. Much of this data has already been published in graphical form;⁽²⁻⁵⁾ however, for some purposes, data can be more useful in tabular form. Therefore, this document, the final report on the high-temperature irradiations of graphite, covers all irradiation data obtained during the period August 1967 to June 1972; June 30, 1972, marks the termination date for the USAEC supported Nuclear Graphite program and, with it, the termination of the series of high-temperature graphite irradiations.

EXPERIMENTAL

DESCRIPTION OF SAMPLES

Irradiation data are reported on the 48 types of graphites described in Table I. The sampling schemes are shown in Figures A-1 through A-6 of Appendix A; the appropriate figure number is listed in Table I for each type of graphite.

Samples were prepared by machining to cylindrical shape (nominally 0.250 inches in diameter and 1.75 inches long); the ends of the samples were rounded and polished to facilitate length measurements and the samples were then annealed in vacuum for one hour at 1600 to 1800 °C to relieve stresses introduced during sample preparation.

PROPERTY MEASUREMENTS

Length measurements on the samples were made with a Bausch and Lomb DR-25 Optical Comparator; although length measurements can be made to 10^{-5} inches, bowing of some samples at the higher fluences may reduce the accuracy of the measurements to less than 10^{-4} inches. Elastic modulus was measured using a sonic resonance technique.⁽⁶⁾ Electrical resistivity was determined by measuring the voltage drop between two accurately-spaced knife edges, while passing a known current through the sample. The average coefficient of thermal expansion was measured from 25 to 425 °C, using a fused quartz dilatometer.

IRRADIATION CAPSULES

Design of the H-2-2X series and the GEH-13-1X series of irradiation capsules has been reported previously.⁽²⁾ Samples were contained in individual holes drilled in a cylindrical graphite sample holder. Sample holders were centered in the capsule by alumina rods imbedded in their sides and were separated from adjacent holders by alumina rods. The width of gas gap between the holder and the capsule wall was selected to provide the desired heat-transfer characteristics at each location; additional temperature control was provided by adjusting the composition of the helium - argon gas mixture during operation.

Temperatures of the sample holders were monitored by Geminol (N,P) or W 5% Re/W 26% Re thermocouples; temperatures listed for

the samples in Tables III to XI are fluence averaged values for the holders in which they were located, and are corrected for thermocouple decalibration as discussed in Appendix B. Neutron fluences were determined from the activities of nickel and cobalt and/or iron wires irradiated with the capsules; fluence monitoring is discussed in more detail in Appendix C.

In capsules GEH-13-15 through -17, one of the sample holders was insulated with carbon felt to increase the irradiation temperature; although the temperature gradually decreased as the felt deteriorated during operation, it averaged approximately 1400 °C.

The GEH-13-42X capsule design incorporated several changes. The primary change was that the capsule diameter was increased to 2-1/2 inches from the previous 2 inch diameter; a second change, the insertion of tungsten rods in sample holder No. 12, allowed this holder to operate at a more nearly constant temperature than was obtainable with the carbon felt insulation.

Irradiation histories of the individual capsules are outlined in Table II. Measurements were not obtained after discharge of capsule GEH-13-16; this capsule suffered physical damage during fuel charging and was prematurely removed from the Engineering Test Reactor (ETR). Because of the low neutron fluence, samples from GEH-13-16 were transferred to GEH-13-17 without obtaining measurements. Data obtained after discharge of each of the other capsules are listed in Tables III through IX inclusive; additional data obtained on five types of experimental graphites, which were irradiated in the GEH-13-45X and GEH-13-48X capsules, are listed in Tables X and XI.

TABLE I. Graphite Description

Graphite Type	Sample Prefix Numbers	Block Size, in.	Sample Scheme Figure Number	Manufac-turer	Coke			Binder	Additive	Impregnations		Forming Method	Graphitization Temperature, °C	Description	Density, g/cm ³	Typical Properties									
					Source	Type	Shape			Number	Type					CTE (25-425C) in./in./°C × 10 ⁶	Resistivity, ohm-cm × 10 ⁻⁴		Young's Modulus, psi × 10 ⁻⁶		X-Ray Parameters, Å				
																	Transverse	Parallel	Transverse	Parallel	Transverse	Parallel	c	L _c	a
CSF	233	4 × 4	1	UCC	Cleves	Petroleum	Conventional	Coal tar pitch	None	1	Coal tar pitch	Extruded	2800	Reactor Grade, normal bake, F-purified.	1.66	3.79	1.78	13.3	7.7	0.70	1.58	6.731	513	2.4638	764
TSX	185, 234	6 × 6	1	UCC	Continental-Lake Charles	Petroleum	Needle	Coal tar pitch	None	1	Coal tar pitch	Extruded	3000	Reactor grade, N-Reactor graphite, normal bake, halogen purified, anisotropic.	1.71	3.99	1.01	12.6	6.0	0.89	2.01	6.734	544	2.4639	847
NC8	NC8	17 1/2 × 17 1/2	1	UCC	Continental-Lake Charles	Petroleum	Needle	Coal tar pitch	None	1	Coal tar pitch	Extruded	2800	Reactor grade, EGCR graphite, normal bake.	1.72	3.34	1.66	11.0	6.7	0.83	1.50	6.729	516	2.4638	1016
TSGBF	125, 225	3 3/4 × 3 3/4	1	UCC	Texas-Lockport	Petroleum	Conventional	Coal tar pitch	None			Extruded	2450	Reactor grade, graphitized and F-purified in one step.	1.65	3.80	2.59	19.9	13.8	0.86	1.58	6.762	340	2.4616	542
	61-70	3 (diam)	2	SCC	GLCC	Petroleum	Needle	Coal tar pitch	1% V ₂ O ₃	1	Coal tar pitch	Extruded	2900	Additive series (DDR-118). Mix: 80% #60 flour and 20% particles through 20 and on 35 mesh screen, normal bake, Cl-purification.	1.54	3.55	1.26	16.3	7.6			6.731	339	2.4620	708
	62-21	3 (diam)	2	SCC	GLCC	Petroleum	Needle	Coal tar pitch	5% Al-powder		None	Extruded	2900	Additive series (DDR-136). Mix: 80% #60 flour and 20% particles through 20 and on 35 mesh screen, normal bake, Cl-purification.	1.52	3.70	1.01								
	63-16	6 (diam) × 6	3	GLCC	Texas-Lockport	Petroleum	Raw	Coal tar pitch	None	None		Molded	2500	Experimental raw-coke graphite, base graphite, isotropic.	1.72	6.53	6.34	16.2	15.6	1.60	1.69	6.752	281	2.4606	696
	63-19	3 × 4 × 6	4*	GLCC	Texas-Lockport	Petroleum	Raw	None	None	None		Molded	2900	Experimental raw-coke graphite with no binder, same series as 63-16.	1.46	5.14	4.45	17.9	17.0	0.60	0.64	6.753	269		
	63-23	3 (diam)	2	SCC	Sohio-Lima	Petroleum	Conventional	Coal tar pitch	None	None		Extruded	2900	Rate of rise of graphitiza-tion temperature series (DDR-164), 50 °C/hr.	1.66	3.32	1.81	14.1	8.3	0.58	1.34	6.731	460	2.4591	952
	63-29	3 (diam)	2	SCC	Sohio-Lima	Petroleum	Conventional	Coal tar pitch	None	None		Extruded	2900	Rate of rise of graphitiza-tion temperature series (See 63-23), 30,000 °C/hr.	1.51	3.05	1.84	14.7	9.5			6.736	500	2.4561	675
	63-30	3 (diam)	2	SCC	GLCC	Petroleum	Needle	Coal tar pitch	None	None		Extruded	700	Maximum binder-temperature series (DDR-164), filler graphitized at 2900 °C.	1.46	4.24	1.35					6.729	490	2.4557	500
	63-33	3 (diam)	2	SCC	GLCC	Petroleum	Needle	Coal tar pitch	None	None		Extruded	2000	Maximum binder-temperature series (See 63-30).	1.48	3.32	1.24	36.7		0.39		6.729	368	2.4585	420
	63-36	3 (diam)	2	SCC	GLCC	Petroleum	Needle	Coal tar pitch	None	None		Extruded	2900	Maximum binder-temperature series (See 63-30).	1.50	3.45	0.96	23.6	10.2	0.70	1.10	6.726	600	2.4604	705
	63-37	3 (diam)	2	SCC	Witco	Pitch	Raw	Coal tar pitch	Fe ₃ O ₄	None		Extruded	2900	Maximum shrinkage experi-mental graphite, normal bake, thermal purification.	1.63	6.00	3.68					6.744	272	2.4595	505
	63-38	4 × 4 × 6	4	GLCC	Texas-Lockport	Petroleum	Raw	None	None	None		Molded	2500	Experimental raw-coke graphite with no binder, same as 63-19 except 2500 °C.	1.35	6.19	4.82	39.4	31.2	0.41	0.46	6.768	281	2.4610	570
H-309	64-13, 64-13B	4 × 4 × 6	4	GLCC	Texas-Lockport	Petroleum	Calcined	Coal tar pitch	None	None		Molded	2500	Coking series (DDR-177), fully calcined coke.	1.55	4.85	3.41	25.5	20.7	0.56	0.56	6.740	286	2.4600	>2000

TABLE I. (Con'd)

Graphite Type	Sample Prefix Numbers	Block Size, in.	Sample Scheme Figure Number	Manufac-turer									Graphitization Temperature, °C	Description	Density g/cm ³	Typical Properties									
					Coke			Binder	Additive	Impregnations		Forming Method				CTE (25-425C)		Resistivity, Ω		Young's Modulus, Psi × 10 ⁻⁶		X-Ray Parameters, Å			
					Source	Type	Shape			Number	Type					in./in.°C × 10 ⁶	Transverse	Parallel	Transverse	Parallel	Transverse	Parallel	c	L _c	a
H-313	64-17, 64-17B	4 × 4 × 6	4*, 4	GLCC	Texas-Lockport	Petroleum	Raw	None	None	None		Molded	2500	Coking series (See 64-13), raw coke.	1.53	6.10	4.99	14.1	11.8	1.30	1.18	6.740	252	2.4611	995
780S	64-18, 65-3	5 (diam)	2	SCC	Texas	Petroleum		Coal tar pitch	None	1	Coal tar pitch	Extruded	2800	Experimental graphite.	1.81	3.18	2.11	14.8	10.2	1.48	1.75				
JOZ	65-18	7 1/4 (diam) × 7 1/2	3	GLCC	GLCC	Petroleum	Raw	Coal tar derivative	None	1	Coal tar pitch	Molded	2800	Commercial Grade JOZ isotropic graphite.	1.72	6.65	5.83	14.8	12.9	1.34	1.37	6.749	256		
DS-13	65-20, 66-66	6 × 6 × 3/4 3 3/4 × 3 3/4 × 1 3/4	5*, 5*	PCC		Petroleum			None	None		Isostatically Molded	2800	High purity special graphite, halide purification.	1.82	5.00	3.76	17.0	13.6	0.42	1.88	6.740	224		
SX-4	65-21	4 × 18	1	SCC	SCC	Proprietary	Complex	Coal tar pitch	None			Extruded	2800	Commercial grade isotropic graphite, halide purification.	1.73	4.85	3.85	10.4	9.1	1.27	1.59	6.735	260		
SX-5	65-22	4 × 18	1	SCC	SCC		Isotropic	Coal tar pitch	None			Extruded	2800	Isotropic experimental graphite, normal bake.	1.73	5.26	4.88	9.9	9.9	1.36	1.25	6.737	287		
GN	65-29	4 1/4 (diam)	2	BCC			Non-needle		None	Multiple	Coal tar pitch	Extruded	2650	Nuclear grade, pre-graphitized coke.	1.87	2.81	1.99	13.7	10.8	1.25	1.74	6.736	262		
H-319	65-32	3 (diam)	2	GLCC	GLCC	Petroleum		Coal tar pitch	None	None		Special Process	2800	Isotropic experimental graphite.	1.78	3.54	3.23	10.0	9.2	1.20	1.90	6.732	297	2.458	
9567	65-37, 66-12	5 × 13, 18 (diam)	1, 2	SCC	SCC		Needle	Coal tar pitch	~1% FeO	>1	Coal tar pitch	Extruded	2800	Experimental graphite, available in large sizes.	1.71	3.62	1.42	9.6	5.8	0.90	1.70	6.722	376		
MSRE	65-38, 66-7	2 1/4 × 2 1/4 1 1/2 × 1 1/2	1	UCC		Petroleum		Coal tar pitch	None	2	Resin	Extruded	2800	MSRE core graphite, low permeability, fine grain, gas purified.	1.86	3.43	0.84	17.2	5.7			6.734	313		
AXF-8Q1	65-42, 67-5	2 (diam) × 6 1 1/2 × 2 × 6	6*, 5	POCO	Proprietary	Proprietary	Approximately Spherical		None	None		Isostatically Molded	2800	Fine grain, high strength, isotropic, high CTE, largest particles <50 microns, halide purification, total ash 5 ppm.	1.79	7.05	7.16	16.1	15.4	1.68	1.75				
AXZ-5Q1	66-4	1 1/2 × 4 × 18	5*	POCO	Proprietary	Proprietary	Approximately Spherical		None	None		Isostatically Molded	>2500	Fine grain, isotropic low density.	1.51	6.82	6.52	17.0	16.4	1.10	1.16				
H-327A	66-9	12 3/4 (diam)	2	GLCC		Petroleum	Needle	Coal tar pitch	None	>1	Coal tar pitch	Extruded	2800	Commercial graphite avail-able in large size on developmental basis.	1.78	3.37	1.22	11.3	5.6			6.716	770	2.460	
H-328	66-10	17 3/8 (diam) × 4	3*	GLCC	GLCC		Isotropic		None	1	Coal tar pitch	Molded	2800	Developmental.	1.72	5.74	5.67	12.0	11.8	1.50	1.56	6.742	360	2.460	
H-207-85	66-11, GLZ	6 (diam)	3	GLCC	GLCC		Isotropic	Coal tar pitch	None	>1	Coal tar pitch	Molded	2800	Developmental.	1.82	5.81	4.73	10.7	9.1	1.65	1.56	6.750	224		
H-349	66-13		3	GLCC	GLCC	Petroleum	Needle	Coal tar pitch	None			Special Process		Special process, baked under pressure.	1.64	2.87	1.26	16.0	8.2						
9640	66-14	8 1/2 (diam) × 9	3	SCC	SCC		Needle		None			Molded (Not conventional)	2800	Needle coke isotropic.	1.58	3.8	3.6	15.7	15.3		1.24				
9650	66-15	4 1/4 × 4	1*	SCC	Proprietary		Non-needle		None			Extruded	2800	Raw coke.	1.92	7.4	7.2		40.2		0.85				
9751	67-1	2 5/8 × 12 × 12	3	SCC	SCC		Non-needle		None			Molded	2800	Isotropic, gas-purified, no impregnation.	1.73	6.9	6.2		19.3						

TABLE I. (Con'd)

Graphite Type	Sample Prefix Numbers	Block Size, in.	Sample Scheme Figure Number	Manufac-turer	Coke			Binder	Additive	Impregnations		Forming Method	Graphitization Temperature, °C	Description	Density g/cm ³	Typical Properties										
					Source	Type	Shape			Number	Type					CTE (25-425C) in./in.°C × 10 ⁶		Resistivity, ohm-cm × 10 ⁴		Young's Modulus, Psi × 10 ⁻⁶		X-Ray Parameters, Å				
																Transverse	Parallel	Transverse	Parallel	Transverse	Parallel	c	L _c	a	L _a	
RC-4	67-3	12 (diam)	2	SCC	SCC	Proprietary	Complex	Coal tar pitch	None			Extruded	2800	Commercial grade isotropic same as 65-21 except not purified.	1.73											
AXF-5QBGl	62-4	1 1/2 × 2 × 6	5	POCO	Proprietary	Proprietary	Approximately Spherical		None	1		Isostatically Molded	2500	Fine grain, high strength, isotropic, high CTE, halide purification.	1.89	7.2	7.2	16.3	16.3	2.0	2.0					
AXZ-8Q1	67-6, 67-24	1 1/2 × 2 × 6 2 (diam) × 6	5, 6*	POCO	Proprietary	Proprietary	Approximately Spherical		None	None		Isostatically Molded	2800	Fine grain, isotropic low density.	1.53	6.2	6.2	16.0	16.0							
AXF-5Q1	67-7	1 1/2 × 2 × 6	5	POCO	Proprietary	Proprietary	Approximately Spherical		None	None		Isostatically Molded	2500	Fine grain, isotropic.	1.81	7.2	7.2	14.6	14.6	2.0	2.0					
AXF-8QBGl	67-8	1 1/2 × 2 × 6	5	POCO	Proprietary	Proprietary	Approximately Spherical		None	1		Isostatically Molded	2800	Fine grain, isotropic.	1.89	6.5	6.5	10.0	10.0	2.0	2.0					
AXF-Q1	67-9	1 1/2 × 2 × 6	5	POCO	Proprietary	Proprietary	Approximately Spherical		None	None		Isostatically Molded	2300	Halide purification	1.83	7.2	7.2									
	68-1A	2 1/2 (diam)	2	SCC	SCC		Isotropic	CTP	None	None		Extruded	2500	Same as 65-22 except lower graphitization temperature, baked at 800 °C.	1.73											
	68-2A	2 1/2 (diam)	2	SCC	SCC		Isotropic	CTP	None	None		Extruded	2500	Same as 68-1A except baked at 1400 °C.	1.73											
ACI4-6	AC	1/2 (diam)	2*	LASL	Santa Maria	Petroleum	Pregraphitized	Resin	None	None		Extruded	2800	Mix: 85 parts graphite flour, 15 parts thermax, 25 parts furfuryl alcohol resin.	1.86											
63F-10	3F	3 (diam) × 2 1/4	3*	LASL	Santa Maria	Petroleum	Pregraphitized	Resin	None	None		Molded	2800	No thermax, 23 parts resin per 100 parts graphite flour.	1.77											
63H-7	3H	3 (diam) × 2 1/4	3*	LASL	Santa Maria	Petroleum	Pregraphitized	CTP	None	None		Molded	2800	No thermax, 27 pph coal tar pitch.	1.80											
63L-1	3L	3 (diam) × 2 1/4	3*	LASL	Santa Maria	Petroleum	Calcined	CTP	None	None		Molded	2800	No thermax, coarser ground filler than 3H, calcined at 90 °C - not pregraphitized 20 pph coal tar pitch.	1.64											
BXT-5Q1	BX	2 × 2 × 7	5	POCO	Proprietary	Proprietary						Isostatically Molded	2500	Coarser grained than 67-7.	1.67											

* Note that Sample Suffix Numbers do not indicate normal sample Orientation in Block.

TABLE II. Capsule History.

<u>Capsule No.</u>	<u>Reactor Position</u>	<u>Installation Date</u>	<u>Reactor Cycles</u>	<u>Effective Days</u>	<u>Removal Date</u>
H-3-26	GETR E5	7/67	87-89	48.8	9/67
H-3-27	GETR E5	10/67	90-91	52.7	12/67
GEH-13-13	ETR K-7	12/66	86-87	46.1	3/67
GEH-13-14	ETR L-8	8/67	91-93	95.9	1/68
GEH-13-15	ETR L-8	6/68	96-98	93.5	10/68
GEH-13-16	ETR L-8	3/69	101A	15.2	3/69
GEH-13-17	ETR L-8	7/69	103-104	83.1	11/69
GEH-13-421	ETR I-12	9/70	109-110	106.7	3/71
GEH-13-422	ETR I-12	9/71	113-114D	74.9	1/72
GEH-13-451	ETR L-8	7/70	108-110B	122.3	2/71
GEH-13-481	ETR L-8	7/70	108-110B	122.3	2/71
GEH-13-452	ETR L-8	9/71	113-114	91.5	2/72
GEH-13-482	ETR L-8	9/71	113-114	91.5	2/72

TABLE III. H-3-26 and H-3-27 Experimental Results

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Capsule Position	Sample Number	No. of Previous Irradiations	H-3-26			H-3-27		
			Temp., °C	Fluence, nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	Temp., °C	Fluence, nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %
1	NC8-154	3	550	2.61	-0.517	550	3.05	-0.643
	NC8-253	3	550	3.00	-0.787	550	3.44	-0.960
	185-151	3	550	2.61	-0.544	550	3.05	-0.685
	185-250	3	550	2.61	-0.825	550	3.05	-1.034
	125-36	3	550	2.61	-0.535	550	3.05	-0.670
	125-239	3	550	2.61	-0.819	550	3.05	-1.028
	65-18-64	3	550	2.61	-0.055	550	3.05	-0.110
	65-18-262	3	550	2.61	-0.237	550	3.05	-0.328
	65-22-1	3	550	2.61	-0.232	550	3.05	-0.318
	65-22-201	3	550	2.61	-0.406	550	3.05	-0.488
	65-37-3	3	550	3.00	-0.462	550	3.44	-0.561
	66-7-4	1	500	1.19	-0.248	525	1.63	-0.393
	66-7-9	1	500	1.19	-0.247	525	1.63	-0.421
	66-7-200	1	500	1.19	-0.304	525	1.63	-0.480
	66-7-205	1	500	1.19	-0.317	525	1.63	-0.498
	GLZ-3	3	550	3.00	-0.378	550	3.44	-0.469
	GLZ-201	3	550	3.00	-0.522	550	3.44	-0.675
	D6189		500	1.19	-0.451	525	1.63	-0.606
	D6216		500	1.19	-0.383	525	1.63	-0.511
2	65-22-202	0	500	0.75	-0.134	575	1.47	-0.441
	65-38-10	0	500	0.75	-0.078	575	1.47	-0.177

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TABLE III: (Con'd)

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Capsule Position	Sample Number	No. of Previous Irradiations	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change ΔL/L ₀ , %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change ΔL/L ₀ , %
2	65-38-11	0	500	0.75	-0.134	575	1.47	-0.169
	65-38-203	0	500	0.75	-0.101	575	1.47	-0.270
	66-7-201	0	500	0.75	-0.107	575	1.47	-0.283
	67-4-9	0	500	0.75	+0.006	575	1.47	+0.075
	67-4-10	0	500	0.75	+0.002	575	1.47	+0.063
	67-8-4	0	500	0.75	+0.014	575	1.47	+0.073
	67-8-7	0	500	0.75	+0.017	575	1.47	+0.057
	67-8-8	0	500	0.75	-0.021	575	1.47	+0.046
	67-8-9	0	500	0.75	+0.013	575	1.47	+0.048
	D2911		500	0.75	-0.312	575	1.47	-0.483
	D3802		500	0.75	-0.213	575	1.47	-0.424
	D4003		500	0.75	-0.229	575	1.47	-0.457
	D4205		500	0.75	-0.138	575	1.47	-0.207
	D4406		500	0.75	-0.254	575	1.47	-0.473
	D4808		500	0.75	-0.234	575	1.47	-0.376
	D5009		500	0.75	-0.216	575	1.47	-0.397
	D5210		500	0.75	-0.236	575	1.47	-0.426
4	185-154	3	875	7.15	-0.572	875	8.41	-0.130
	185-254	3	875	7.15	-3.983	875	8.41	-5.216
	125-33	3	875	7.15	+4.695	875	8.41	+7.977
	125-230	3	875	7.15	-4.800	875	8.41	-3.978
	63-16-202	3	875	7.15	-0.970	875	8.41	-0.885

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TABLE III: (Con'd)

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Capsule Position	Sample Number	No. of Previous Irradiations	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %
4	63-38-5	3	875	7.15	-0.099	875	8.41	+1.084
	65-22-4	3	875	7.15	-0.312	875	8.41	-0.282
	65-37-11	2	875	5.13	-0.221	875	6.39	-1.600
	65-37-218	2	875	5.13	-1.997	875	6.39	-2.863
	66-9-43	2	875	5.13	-0.783	875	6.39	-0.917
	66-9-223	1	850	3.06	-0.731	850	4.32	-1.370
	66-13-2	2	875	5.13	-1.808	875	6.39	-1.598
	66-13-200	2	875	5.13	-3.591	875	6.39	-4.887
	66-14-8	1	850	3.06	-0.427	850	4.32	-0.683
	66-14-207	1	850	3.06	-0.488	850	4.32	-0.830
	D5412		850	3.06	+0.084	850	4.32	+0.051
	D5613		850	3.06	+0.016	850	4.32	-0.039
	D5814		850	3.06	+0.021	850	4.32	-0.261
	D7421		850	3.06	-0.169	850	4.32	-0.964
5	233-36	2	950	6.16	-0.673			
	63-16-13	2	950	6.16	-0.927			
	63-16-210	2	950	6.16	+0.315			
	63-38-222	2	950	6.16	-3.433			
	65-18-72	2	950	6.16	+1.036	950	7.69	+1.537
	65-18-279	2	950	6.16	-1.700	950	7.69	-1.920
	65-21-8	2	950	6.16	-1.338	---	---	---
	65-21-209	2	950	6.16	-2.529	950	7.69	-3.062

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TABLE III: (Con'd)

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Capsule Position	Sample Number	No. of Previous Irradiation	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %
11	5	65-22-18	2	950	6.16	-1.148		
		65-22-207	2	950	6.16	-1.905		
		65-42-2	2	950	6.16	+1.576		
		65-42-200	2	950	6.16	+1.589		
		66-4-1	2	950	6.16	+0.516	950	7.69
		66-4-201	2	950	6.16	+0.930	950	7.69
		67-3-4	1	925	3.68	-0.560		
		67-3-200	1	925	3.68	-1.254		
		67-1-14	1	925	3.68	+0.691		
		67-1-200	1	925	3.68	-0.078		
11	7	222-201	4	1000	12.85	-5.192	---	---
		225-20	3		---	---	975	10.82
		61-73-219	4	1000	12.85	-4.274	---	---
		65-21-206	4	1000	12.68	-2.358	1000	14.71
		65-22-5	4	1000	12.85	+2.082	---	---
		65-22-205	4	1000	12.85	-1.470	1000	14.88
	8	65-21-26	1	1050	4.90	-1.159	1050	7.05
		65-21-231	1	1050	4.90	-2.506	1050	7.05
		65-22-31	1	1050	4.90	-0.907	1050	7.05
		65-22-214	1	1050	4.90	-1.611	1050	7.05
11		65-37-24	1	1050	4.90	-1.479	1050	7.05
		65-37-210	1	1050	4.90	-3.094	1050	7.05
		66-9-3	1	1050	4.90	-1.349	1050	7.05

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TABLE III: (Con'd)

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Position	Sample Number	No. of Previous Irradiation	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change ΔL/L ₀ , %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change ΔL/L ₀ , %
8	66-9-232	1	1050	4.90	-4.732	1050	7.05	-7.296
	66-10-24	1	1050	4.90	-1.665	1050	7.05	-1.694
	66-10-26	1	1050	4.90	-1.405	1050	7.05	-1.683
	66-10-226	1	1050	4.90	-1.198	1050	7.05	-1.266
	66-14-4	1	1050	4.90	-1.139	1050	7.05	-1.191
	66-14-204	1	1050	4.90	-1.827	1050	7.05	-2.407
	66-15-3	1	1050	4.90	+0.275	1050	7.05	-0.662
	66-15-205	1	1050	4.90	+0.953	1050	7.05	+1.074
	67-1-10	1	1050	4.90	+1.779	1050	7.05	+2.738
	67-1-206	1	1050	4.90	-0.386	1050	7.05	-0.407
	67-3-1	1	1050	4.90	-0.982	1050	7.05	-0.751
	67-3-203	1	1050	4.90	-3.228	1050	7.05	-3.836
9	233-20	2	1050	8.44	+3.385	1050	10.59	+8.951
	62-21-3	1	1050	4.95	-0.289	1050	7.10	-0.147
	62-21-200	1	1050	4.95	-1.743	1050	7.10	-3.337
	63-37-11	0	1050	1.99	+0.256	1050	4.14	+0.573
	63-37-12	0	1050	1.99	+0.304	1050	4.14	+0.681
	63-37-250	0	1050	1.99	-0.260	1050	4.14	-1.389
	63-37-252	0	1050	1.99	-0.330	1050	4.14	-1.437
	65-21-10	2	1050	8.44	-0.825	1050	10.59	+0.086
	65-21-213	2	1050	8.44	-3.098	1050	10.59	-2.870
	65-22-28	2	1050	8.44	-0.802	1050	10.59	-0.115

TABLE III: (Con'd)

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Capsule Position	Sample Number	No. of Previous Irradiation	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %
9	65-22-211	2	1050	8.44	-2.268	1050	10.59	-1.869
	65-42-9	2	1050	8.44	+2.165	1050	10.59	+2.807
	65-42-202	2	1050	8.44	+1.812	1050	10.59	+2.266
	66-4-2	2	1050	8.44	-0.237	1050	10.59	-0.503
	66-4-202	2	1050	8.44	+0.469	1050	10.59	+0.253
	66-14-6	1	1050	4.95	-1.189	1050	7.10	-1.117
	66-14-200	1	1050	4.95	-1.772	1050	7.10	-2.376
	D6015		1050	4.95	+1.464	1050	7.10	+5.344
10	D6417		1050	4.95	+0.559	1050	7.10	+4.125
	NC8-258	3	1025	13.24	-1.958	---	---	---
	167-212	3	975	12.03	-10.682	---	---	---
	65-18-266	3	975	9.52	+0.721	---	---	---
	65-20-253	3	975	12.03	-0.932	---	---	---
	65-37-201	3	1025	13.24	-6.576	---	---	---
	NC8-158	3	950	7.28	+0.297	---	---	---
	NC8-264	3	950	7.28	-4.703	---	---	---
12/5	63-16-4	3	950	7.28	+0.149	950	8.81	+1.587
	63-16-204	3	950	7.28	+0.558	950	8.81	+0.616
	63-17-5	2	950	5.73	-0.436	950	7.26	+0.460
	63-17-203	2	950	5.73	-1.022	950	7.26	-0.727
	63-19-20	2	950	5.73	-2.488	---	---	---
	63-19-223	2	950	5.73	-0.274	---	---	---

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TABLE III: (Con'd)

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Capsule Position	Sample Number	No. of Previous Irradiations	H-3-26			H-3-27		
			Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	Temp., °C	Fluence nvt x 10 ⁻²¹ (E > 0.18 MeV)	Length Change, $\Delta L/L_0$, %
12/5	63-38-30	2	950	5.73	+1.562	950	7.26	+5.940
	63-38-226	2	950	5.73	-3.975	950	7.26	-3.306
	65-18-82	0	950	1.36	+0.341	---	---	---
	65-18-286	0	950	1.36	+0.147	---	---	---
	65-21-1	1	950	3.36	-0.104	---	---	---
	65-22-6	3	925	7.28	+0.219	950	8.81	+0.498
	65-22-204	3	925	7.28	-2.252	950	8.81	-2.356
	65-37-21	2	950	5.73	-1.653	950	7.26	-1.351
	65-37-202	3	950	7.28	-5.485	950	8.81	-6.732
	D6618		950	3.36	-0.280	950	4.89	+1.065
	D7220		950	3.36	-0.724	950	4.89	-0.221

TABLE IV. GEH-13-13 Experimental Results

					Page 1 of 8			
Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	<u>Electrical Resistivity</u>		<u>Coeff. of Thermal Expansion</u>	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
					<u>Initial</u>	<u>Final</u>	<u>Initial</u>	<u>Final</u>
1	825	0.44	NC8-23A	+0.005	11.4	21.4	3.42	2.94
	825	0.44	63-16-21	+0.019	15.9	21.9	6.43	6.29
	825	0.44	63-16-219	+0.021	15.2	21.3	6.20	5.95
	825	0.44	64-17B-24	+0.016	13.9	22.9	5.78	6.14
	825	0.44	64-17B-214	+0.011	11.9	19.6	5.17	5.02
	825	0.44	65-18-101	+0.027	16.6	24.2	6.70	6.69
	825	0.44	65-18-201	+0.048	14.9	22.0		6.42
	825	0.44	66-9-13	+0.002			3.51	3.15
	825	0.44	66-9-213	-0.021	5.82	11.2	1.25	0.83
	825	0.44	66-12-2	+0.013		21.4	3.49	3.19
	825	0.44	66-12-204	-0.014	5.80	11.7	1.29	1.15
2	950	0.64	NC8-24A	-0.056	10.5	22.0	3.32	2.93
	950	0.64	NC8-358	-0.085		13.7		1.13
	950	0.64	233-26	-0.077	13.1	25.5	3.55	3.69
	950	0.64	233-210	-0.104	7.38	15.2	1.69	1.48
	950	0.64	234-134	-0.058	12.6	25.3	3.67	3.56
	950	0.64	234-304	-0.129		12.5	0.95	0.75
	950	0.64	63-16-22	+0.015				
	950	0.64	63-16-220	+0.015				
	950	0.64	64-17B-32	-0.001	14.3	24.9	5.63	6.27
	950	0.64	64-17B-216	-0.033	11.8	20.7		5.18
	950	0.64	65-18-105	+0.053				
	950	0.64	65-18-298	-0.003	13.7	22.1		5.87
	950	0.64	66-9-17	-0.057	11.6	23.3	4.21	3.34
	950	0.64	66-9-212	-0.126		11.5	1.25	1.05
	950	0.64	66-12-5	-0.059	11.3	24.9	3.69	3.52
	950	0.64	66-12-203	-0.086		12.8	1.56	0.89
3	1000	0.87	NC8-26A	-0.146	11.2	25.5	3.53	3.20
	1000	0.87	NC8-334	-0.298	6.87	16.5		1.14

a. Mean CTE, 25-425 °C.

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TABLE IV: (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
					Initial	Final	Initial	Final
3	1000	0.87	65-21-25	-0.181				
	1000	0.87	65-21-219	-0.322				
	1000	0.87	65-22-7	-0.176				
	1000	0.87	65-22-222	-0.268				
	1000	0.87	66-9-18	-0.208	11.3	23.6	3.35	3.01
	1000	0.87	66-9-214	-0.326	5.77	12.9	1.18	0.76
	1000	0.87	66-10-19	-0.276	12.1	20.1	5.34	5.66
	1000	0.87	66-10-216	-0.186	12.2	20.5	5.62	6.09
	1000	0.87	66-12-6	-0.207	11.3	25.5	3.63	3.42
	1000	0.87	66-12-214	-0.307	6.62	15.4	1.43	1.12
4	1025	1.07	NC8-28A	-0.315	11.0	25.1		3.00
	1025	1.07	NC8-339	-0.490	6.54	15.3		1.11
	1025	1.07	234-144	-0.367	12.4	26.9	3.66	3.53
	1025	1.07	234-296	-0.642	5.92	13.6	0.99	0.81
	1025	1.07	63-23-4	-0.408		31.3	3.25	3.32
	1025	1.07	63-23-202	-0.514	8.31	18.3	1.83	1.23
	1025	1.07	63-29-6	-0.856		31.5	3.06	2.56
	1025	1.07	63-29-201	-0.924			1.99	1.38
	1025	1.07	63-30-1	-1.052				
	1025	1.07	63-30-201	-1.401				
	1025	1.07	63-33-6	-0.968	36.7	54.8		
	1025	1.07	63-36-1	-0.810		39.4	4.40	2.66
	1025	1.07	63-36-201	-0.574		21.7	0.94	0.64
	1025	1.07	65-42-16	+0.264			8.04	6.20
	1025	1.07	65-42-212	+0.254	16.4	24.5	6.89	7.30
	1025	1.07	66-9-44	-0.445	11.0	22.3		3.42
	1025	1.07	66-9-215	-0.267	5.62	12.3	1.19	0.88
	1025	1.07	66-13-2	-0.755				
	1025	1.07	66-13-201	-1.159				
5	1100	1.26	NC8-29A	-0.513	10.9	25.2	3.13	2.66

a. Mean CTE, 25-425 °C.

TABLE IV: (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
					Initial	Final	Initial	Final
5	1100	1.26	NC8-340	-0.757	6.59	15.8	1.44	0.62
	1100	1.26	63-16-23	-0.077				
	1100	1.26	63-16-225	-0.172				
	1100	1.26	64-13B-19	-0.422	24.6	44.1	4.65	4.77
	1100	1.26	64-13B-213	-0.837	20.0	36.0	3.24	3.16
	1100	1.26	64-17B-33	-0.398				
	1100	1.26	64-17B-224	-1.059				
	1100	1.26	65-3-1	-1.017		23.3	2.77	2.75
	1100	1.26	65-3-200	-1.317		16.5	1.82	1.56
	1100	1.26	65-18-113	+0.037		24.1		6.72
	1100	1.26	65-18-299	-0.332				
	1100	1.26	65-22-8	-0.621				
	1100	1.26	66-9-20	-0.594	11.5	24.1	3.28	3.19
	1100	1.26	66-9-216	-0.141	5.68	12.9	1.32	0.96
	1100	1.26	66-10-23	-0.655	11.9	19.6	5.83	5.70
	1100	1.26	66-10-229	-0.690	12.1	19.8		5.90
	1100	1.26	66-13-3	-0.922				
	1100	1.26	66-13-202	-1.528				
6	1150	1.44	NC8-30A	-0.624	10.8	23.2		3.03
	1150	1.44	NC8-342	-1.227	6.30	14.8		1.07
	1150	1.44	233-45	-0.677	12.8	26.7	3.41	3.17
	1150	1.44	233-245	-1.429	7.41	16.8	1.48	1.29
	1150	1.44	234-146	-0.531		26.5	3.67	3.59
	1150	1.44	234-216	-1.554	5.74	13.3	1.10	0.81
	1150	1.44	65-18-115	-0.104				
	1150	1.44	65-18-300	-0.619				
	1150	1.44	65-21-27	-0.747				
	1150	1.44	65-21-221	-1.109				
	1150	1.44	65-22-9	-0.765				
	1150	1.44	65-22-223	-0.850				

a. Mean CTE, 25-425 °C.

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TABLE IV: (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
					Initial	Final	Initial	Final
7	1250	1.58	NC8-32A	-0.812	10.9	22.4	3.32	2.16
	1250	1.58	NC8-344	-1.324	6.57	14.6		1.07
	1250	1.58	225-32	-2.073				3.95
	1250	1.58	233-65A	-0.858	12.7	25.0		3.34
	1250	1.58	233-262	-1.431	7.83	16.0		1.50
	1250	1.58	61-70-16	-0.961	15.5	34.0	3.56	3.03
	1250	1.58	61-70-222	-1.563	7.80	18.3	1.52	0.83
	1250	1.58	63-23-6	-1.037	14.0	25.4	3.41	3.25
	1250	1.58	63-23-205	-1.413	8.35	16.1	1.89	1.71
	1250	1.58	63-29-7	-2.154	14.8	27.0	3.05	2.66
	1250	1.58	63-29-207	-2.687	9.48	17.9	1.76	1.21
	1250	1.58	65-29-3	-1.570	13.4	22.0	2.78	1.96
	1250	1.58	65-29-209	-2.592	10.2	17.5	1.91	1.47
	1250	1.58	65-32-10	-1.319				
	1250	1.58	65-32-206	-1.176				
	1250	1.58	66-4-4	-0.063	17.1	27.0	6.60	6.41
	1250	1.58	66-4-203	+0.031	16.7	26.6	6.67	6.32
	1250	1.58	66-6-33	-0.208			4.94	3.81
	1250	1.58	66-6-232	-1.126				
8	1250	1.72	NC8-33A	-0.738	9.92	21.0		3.11
	1250	1.72	NC8-364	-1.430	6.27	14.3	1.51	1.12
	1250	1.72	63-16-19	-0.404				
	1250	1.72	63-16-226	-0.694				
	1250	1.72	65-18-121	-0.272	14.5	22.6	6.58	6.56
	1250	1.72	65-18-301	-0.919				
	1250	1.72	66-9-21	-0.757				
	1250	1.72	66-9-217	-2.077	5.89	13.2	1.28	0.84
	1250	1.72	66-10-25	-1.134				
	1250	1.72	66-10-222	-1.307				
	1250	1.72	66-11-4	-1.002				

a. Mean CTE, 25-425 °C.

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TABLE IV. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
					Initial	Final	Initial	Final
8	1250	1.72	66-11-213	-1.675				
9	1275	1.82	NC8-34A	-0.803				
	1275	1.82	NC8-345	-1.272				
	1275	1.82	63-16-27	-0.709				
	1275	1.82	63-16-227	-1.016				
	1275	1.82	65-18-122	-0.239				
	1275	1.82	65-18-302	-1.026				
	1275	1.82	66-4-8	-0.088				
	1275	1.82	66-4-204	-0.080				
	1275	1.82	66-9-22	-0.943				
	1275	1.82	66-9-218	-1.192				
10	1300	1.86	NC8-37A	-0.746				
	1300	1.86	NC8-347	-1.583	6.22	14.0		1.11
	1300	1.86	233-47	-0.833				
	1300	1.86	233-248	-1.950	8.18	17.1	1.78	1.59
	1300	1.86	63-16-229	-1.317				
	1300	1.86	64-13B-34	-0.782				
	1300	1.86	64-13B-214	-1.904				
	1300	1.86	64-17B-28	-0.915				
	1300	1.86	64-17B-215	-1.951				
	1300	1.86	65-18-100	-0.509				
	1300	1.86	65-18-303	-1.361				
	1300	1.86	65-21-28	-1.338				
	1300	1.86	65-21-222	-2.574				
	1300	1.86	65-22-17	-1.496				
	1300	1.86	65-22-213	-1.614				
11	1275	1.89	NC8-349	-1.647				
	1275	1.89	225-69	-2.133				
	1275	1.89	225-235	-4.738				

a. Mean CTE, 25-425 °C.

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TABLE IV. (Con'd)

Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Page 6 of 8		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)		10 ⁻⁶ per °C (a)	
					Initial	Final	Initial	Final	Initial	Final
11	1275	1.89	63-16-36	-0.884						
	1275	1.89	63-16-230	-1.140						
	1275	1.89	63-17-1	-1.128						
	1275	1.89	63-17-200	-1.077						
	1275	1.89	63-19-15	-0.861						
	1275	1.89	63-19-217	-1.370						
	1275	1.89	63-38-29	-1.523						
	1275	1.89	63-38-231	-2.293						
	1275	1.89	63-9-207	-2.420						
	1275	1.89	66-10-234	-1.585						
	1275	1.89	66-12-202	-2.364						
	1275	1.86	NC8-43A	-0.868	10.4	21.2			3.12	
	1275	1.86	NC8-352	-0.815						
	1275	1.86	63-30-4	-2.282						
	1275	1.86	63-30-203	-3.550						
	1275	1.86	63-36-2	-1.542					2.78	2.61
12	1275	1.86	63-36-203	-1.725						
	1275	1.86	65-21-9	-1.474						
	1275	1.86	65-21-220	-1.770						
	1275	1.86	65-37-9	-1.442		17.9			2.48	2.36
	1275	1.86	65-37-215	-2.228						
	1275	1.86	65-42-24	+0.040					7.70	7.11
	1275	1.86	65-42-216	+0.000						
	1275	1.86	66-9-219	-2.472						
	1275	1.86	66-13-4	-1.949						
	1275	1.86	66-13-203	-3.868						
	1275	1.82	NC8-44A	-0.778						
	1275	1.82	NC8-355	-1.634						
13	1275	1.82	63-16-38	-0.557						

a. Mean CTE, 25-425 °C.

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TABLE IV. (Con'd)

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Capsule Position	Temp., °C	Fluence ^a nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
					Initial	Final	Initial	Final
13	1275	1.82	63-16-231	-0.975				
	1275	1.82	63-17-2	-0.622				
	1275	1.82	63-17-201	-1.033				
	1275	1.82	63-19-16	-1.362				
	1275	1.82	63-38-239	-2.091				
	1275	1.82	66-9-26	-0.934				
	1275	1.82	66-9-228	-2.622				
	1275	1.82	66-10-42	-1.463				
	1275	1.82	66-10-240	-1.465				
	1275	1.82	66-12-8	-0.708				
	1275	1.82	66-12-221	-2.263				
14	1225	1.66	NC8-45A	-0.798	10.9	23.3		3.07
	1225	1.66	NC8-359	-1.338	6.30	13.9		1.08
	1225	1.66	225-85	-1.997				
	1225	1.66	225-247	-4.400			2.54	2.14
	1225	1.66	61-70-18	-0.970			3.43	3.17
	1225	1.66	61-70-230	-1.949		17.7	1.52	0.97
	1225	1.66	65-22-224	-1.550				
	1225	1.66	65-29-5	-1.806	13.2	20.9	2.78	2.60
	1225	1.66	65-29-210	-2.685	10.5	16.9	2.10	1.68
	1225	1.66	65-42-122	+0.246	16.8	23.9	6.89	5.94
	1225	1.66	65-42-224	+0.243				
	1225	1.66	66-4-10	-0.042	16.5	27.5	6.54	6.69
	1225	1.66	66-6-34	-0.033			4.71	4.83
	1225	1.66	66-6-238	-1.112	13.4	18.2	3.69	3.53
	1225	1.66	66-9-27	-0.783	11.6	24.7	3.51	3.22
	1225	1.66	66-9-229	-1.996	5.78	12.9	0.98	0.79
	1225	1.66	66-11-5	-1.333				
	1225	1.66	66-11-212	-1.771				

a. Mean CTE, 25-425 °C.

TABLE IV. (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	Length Change, $\Delta L/L_0$, %	Electrical Resistivity		Coeff. of Thermal Expansion	
					ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
					Initial	Final	Initial	Final
15	1175	1.45	NC8-46A	-0.634				
	1175	1.45	NC8-363	-1.105	11.3	24.5		3.05
	1175	1.45	234-154	-0.514	6.57	15.5		1.18
	1175	1.45	63-16-40	-0.248		27.6		3.83
	1175	1.45	63-16-234	-0.461				
	1175	1.45	63-17-3	-0.145				
	1175	1.45	63-17-202	-0.372				
	1175	1.45	63-19-19	-0.732				
	1175	1.45	63-19-221	-0.486				
	1175	1.45	63-38-20	-0.427				
	1175	1.45	63-38-238	-1.679				
	1175	1.45	65-18-103	+0.060				
	1175	1.45	65-18-304	-0.653				
	1175	1.45	66-9-28	-0.512	12.2	26.9	3.53	3.31
	1175	1.45	66-9-234	-1.527	5.47	13.5	1.17	0.73
	1175	1.45	66-10-43	-0.743	11.5	20.0	5.30	5.06
	1175	1.45	66-10-230	-0.729	12.0	20.5	5.64	5.06
	1175	1.45	66-12-24	-0.368	12.9	29.9	3.97	4.17
	1175	1.45	66-12-208	-1.315	5.88	15.2	1.32	1.11

a. Mean CTE, 25-425 °C.

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TABLE V. GEH-13-14 Experimental Results

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ⁻²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁻⁴		10 ⁻⁶ per °C ^(a)	
						Initial	Final	Initial	Final	Initial	Final
1	775	1.11	NC8-23A	1	-0.022	0.78	1.11	11.4	28.8	3.42	2.84
	750	0.67	NC8-356	0	-0.041		2.18	6.27	16.9	1.14	1.19
	775	1.11	63-16-21	1	-5.609	1.75	1.58	15.9	27.0	6.43	5.04
	775	1.11	63-16-219	1	+0.059	1.82	1.94	15.2	25.6	6.20	6.23
	775	1.11	64-17B-24	1	+0.046	1.06	1.36	13.9	29.6	5.78	5.78
	775	1.11	64-17B-214	1	+0.004	1.34	1.74	11.9	24.5	5.17	4.79
	775	1.11	65-18-101	1	+0.113	1.25	1.66	16.6	29.6	6.70	6.21
	775	1.11	65-18-201	1	+0.109	1.33	1.81	14.9	27.2		5.82
	775	1.11	66-9-13	1	-0.028	0.89	1.53	12.3	29.9	3.51	3.40
	775	1.11	66-9-213	1	-0.101			5.82	15.1	1.25	1.12
	775	1.11	66-12-204	1	-0.089			5.80	15.9	1.29	0.80
2	900	1.94	NC8-24A	1	-0.280	0.76	1.42	10.5	32.2	3.32	3.15
	900	1.94	NC8-358	1	-0.458	1.68	1.98				
	900	1.94	233-26	1	-0.343	0.73	1.17	13.1	34.8	3.55	1.43
	900	1.94	233-210	1	-0.605	1.68	2.52	7.38	21.6	1.69	1.28
	900	1.94	234-134	1	-0.333			12.5	34.8	3.67	3.06
	900	1.94	234-304	1	-0.702	1.81	2.21				
	875	1.30	63-16-42	0	+0.090		1.69	13.5	26.7	6.30	5.54
	875	1.30	63-16-238	0	+0.029		1.72	13.4	26.3	5.70	5.00
	900	1.94	64-17B-32	1	-0.114	1.07	1.30	14.3	30.7	5.63	6.16
	900	1.94	64-17B-216	1	-0.418	1.24	1.58	11.8	26.2		4.92
	875	1.30	65-18-109	0	+0.165		1.60	13.3	28.7	6.23	5.28
	900	1.94	65-18-298	1	-0.110	1.43	1.81	13.7	27.4		5.80
	900	1.94	66-9-17	1	-0.264	0.89	1.28	11.6	32.0	4.21	3.03
	900	1.94	66-9-212	1	-0.544						
	900	1.94	66-12-5	1	-0.268	0.92	1.17	11.3	33.6	3.69	2.25
	900	1.94	66-12-203	1	-0.444						
3	1000	2.69	NC8-26A	1	-0.572			11.2	32.2	3.53	3.26
	1000	2.69	NC8-334	1	-1.001	1.47	2.04	6.87	20.8		1.25

a. Mean CTE, 25-425 °C.

TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
3	1000	2.69	65-21-25	1	-0.684	1.32	1.93	9.94	23.2		4.18
	1000	2.69	65-21-219	1	-1.022	1.50	2.26	8.82	20.6		2.07
	1000	2.69	65-22-7	1	-0.643	1.34	1.64	9.74	22.0		5.04
	1000	2.69	65-22-222	1	-0.917	1.25	1.78	10.3	22.6		4.63
	1000	2.69	66-9-18	1	-0.643	0.88	1.26	11.3	29.4	3.35	2.58
	1000	2.69	66-9-214	1	-1.420	2.18	3.00	5.77	16.7	1.18	0.71
	1000	2.69	66-10-19	1	-1.083	1.43	1.51	12.1	22.6	5.34	4.33
	1000	2.69	66-10-216	1	-0.931	1.51	1.53	12.2	22.7	5.62	4.64
	1000	2.69	66-12-6	1	-0.438	0.91	1.83	11.3	32.2	3.63	3.44
	1000	2.69	66-12-214	1	-1.392	1.61	2.24	6.62	19.7	1.43	1.11
4	1075	3.41	NC8-28A	1	-0.828			11.0	28.3		2.76
	1075	3.41	NC8-339	1	-2.493	1.58	2.04	6.54	17.9		0.39
	1075	3.41	234-144	1	-0.680	0.76	1.61	12.4	30.2	3.66	2.34
	1075	3.41	234-296	1	-3.090			5.92	15.5	0.99	0.58
	1075	3.41	65-42-16	1	+0.977	0.98	1.31			8.04	5.87
	1075	3.41	65-42-212	1	+0.767		1.25	16.3	25.2	6.89	6.10
	1100	2.34	66-4-18	0	+0.228		1.29	14.2	29.0	6.14	6.03
	1075	3.41	66-9-44	1	-1.091	1.27	1.19	11.0	24.0		2.35
	1075	3.41	66-9-215	1	-3.545	2.24	2.81	5.62	14.2	1.19	0.75
	1100	2.34	67-4-1	0	+0.293			15.5	22.3	7.26	5.93
	1100	2.34	67-4-202	0	+0.503			14.6	22.9	6.92	3.90
	1100	2.34	67-6-1	0	+0.213		1.24	15.0	29.2	5.89	5.96
	1100	2.34	67-6-202	0	+0.410		1.72	12.8	27.3	5.98	4.54
	1100	2.34	67-7-1	0	+0.490		1.85			7.30	6.03
	1100	2.34	67-7-202	0	+0.653		2.09	12.4	20.8	7.13	5.90
	1100	2.34	67-8-1	0	+0.476		2.44	8.91	17.3	6.37	5.08
	1100	2.34	67-8-202	0	+0.444		2.29	9.05	17.5	6.77	4.43
	1100	2.34	67-9-1	0	+0.511		2.34	12.6	19.7	7.25	3.70
	1100	2.34	67-9-202	0	+0.095		2.39	12.4	18.8	7.42	4.70

a. Mean CTE, 25-425 °C.

TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
5	1125	4.01	NC8-29A	1	-0.874	0.81	1.09	10.9	23.7	3.13	2.54
	1125	4.01	NC8-340	1	-3.452	1.54	1.95	6.59	17.8	1.44	0.86
	1125	3.82	63-23-4	1	-1.817				31.9		
	1125	3.82	63-23-202	1	-3.477	1.28	1.70	8.31	19.9	1.83	1.30
	1125	3.82	63-29-6	1	-4.447		0.88			3.06	1.87
	1125	3.82	63-29-201	1	-6.148		1.38			1.99	0.90
	1125	4.01	64-138-19	1	-0.360	0.53	1.78	24.6	42.6	4.65	4.02
	1125	4.01	64-13B-213	1	-3.190			20.0	38.8	3.24	2.56
	1150	2.75	65-21-19	0	-1.593		1.93	8.97	23.2	4.19	4.18
	1150	2.75	65-21-232	0	-2.293			7.86	17.5	3.44	3.08
	1125	4.01	65-22-8	1	-7.582	1.34	1.89	9.67	19.2		0.61
	1150	2.75	65-22-29	0	-7.433		1.60	8.38	18.3	5.21	3.42
	1150	2.75	65-22-210	0	-2.292		1.87	8.74	17.6	4.32	2.49
	1125	4.01	66-10-23	1	-1.880	1.37	2.42	11.9	20.0	5.82	2.30
	1125	4.01	66-10-229	1	-2.110		2.71	12.1	19.2		1.59
	1150	2.75	66-15-6	0	-0.244		1.01	24.6	39.2	5.48	3.79
	1150	2.75	66-15-206	0	-0.120		1.23	22.1	36.0	5.75	4.29
	1150	2.75	67-3-3	0	-1.784		1.22			4.84	3.57
	1150	2.75	67-3-201	0	-2.600		2.08	8.49	17.7	3.88	3.16
6	1200	4.57	NC8-30A	1	-0.776	0.82	1.05	10.8	25.9		1.80
	1200	4.57	NC8-342	1	-4.497	1.50	1.97	6.30	16.2		1.06
	1200	4.57	233-45	1	-1.343	0.72	0.89	12.8	28.9	3.41	2.90
	1200	4.57	233-245	1	-5.475	1.53	1.34	7.41	20.8	1.48	0.71
	1200	4.57	234-146	1	-0.025	0.78	1.07		28.1	3.67	2.74
	1200	4.57	234-216	1	-6.321	1.83	2.17	5.74	14.8	1.10	0.62
	1200	4.57	65-21-27	1	-1.998	1.34	2.30	9.87	18.4		1.54
	1200	4.57	65-22-9	1	-2.032	1.32	2.65	9.79	18.6		1.79
	1200	4.57	65-22-223	1	-2.869	1.23	1.75		19.5		1.78
	1225	3.13	66-14-11	0	-1.596		1.34	9.17	21.8	2.31	1.77
	1225	3.13	66-14-211	0	-2.044		1.54	8.40	20.2	1.98	0.81

a. Mean CTE, 25-425 °C.

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TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
26	8	1275	NC8-32A	1	-0.819			10.9	26.9	3.32	2.15
		1275	NC8-344	1	-3.177	1.52	1.54	6.57	15.7		
		1275	233-65A	1	-1.172			12.6	27.3		2.70
		1275	233-262	1	-4.999	1.59	1.62	7.83	18.0		1.29
		1275	61-70-16	1	-1.275	0.50	1.06	15.5	38.0	3.56	2.62
		1275	61-70-222	1	-4.872	1.50	1.29	7.80	20.4	1.52	0.82
		1275	66-4-4	1	-0.634	1.25	1.26	17.1	29.0	6.60	4.88
		1275	66-4-203	1	-0.398	1.10	1.26	16.7	27.0	6.67	5.65
		1275	66-15-1	0	-0.545			25.3	37.3	5.22	4.62
		1275	66-15-201	0	-0.438				36.2	5.27	5.08
		1275	67-6-2	0	-0.280		1.19	14.5	26.6	5.75	6.26
		1275	67-6-3	0	-0.380		1.16	14.5	27.6	6.43	5.12
	9	1300	NC8-33A	1	-0.936	0.88	1.07	9.92	24.4		2.69
		1300	NC8-364	1	-4.015	1.46	1.73	6.27	16.5	1.51	1.15
		1300	225-32	1	+0.982	0.59	0.80				4.04
		1300	63-23-6	1	-2.021	0.58	1.15	14.0	32.3	3.41	2.93
		1300	63-23-205	1	-3.825	1.39	1.32	8.35	19.0	1.89	1.05
		1300	63-29-7	1	-4.922		0.96	14.8	33.8	3.05	2.27
		1300	63-29-207	1	-6.885		1.27			1.76	0.85
		1300	65-18-121	1	-0.283	1.30	1.38	14.5	22.17	6.58	3.70
		1300	65-29-3	1	-0.120	1.25	1.62	13.5	26.32	2.78	2.64
		1300	65-29-209	1	-4.883	1.75	2.56	10.2	21.21	1.91	1.51
		1300	66-6-33	1	+2.771						
		1300	66-9-217	1	-5.576		1.28			1.28	0.40
	10	1325	NC8-25A	0	-1.039		0.96	9.88	23.4	3.44	2.67
		1325	NC8-331	0	-5.266		1.95	5.65	14.3	1.26	1.04
		1325	NC8-347	1	-4.990	1.60	2.01	6.22	15.4		0.68
		1325	65-21-18	0	-2.116		1.84	8.71	19.4	4.20	3.45
		1325	65-21-28	1	-2.179	1.11	2.29	9.89	18.9		0.84

a. Mean CTE, 25-425 °C.

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TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^4$ ($E > 0.18 \text{ MeV}$)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0, \%$	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						$\text{psi} \times 10^{-6}$		$\text{ohm-cm} \times 10^4$		$10^{-6} \text{ per } ^\circ\text{C (a)}$	
						Initial	Final	Initial	Final	Initial	Final
10	1325	5.94	65-21-222	1	-3.968			8.93	17.0		1.32
	1325	4.08	65-21-227	0	-3.959			7.59	15.7	3.54	2.00
	1325	4.08	65-22-13	0	-2.429		2.27	8.69	16.2	4.90	1.93
	1325	5.94	65-22-17	1	-2.305	1.40	3.15	9.77	17.3	5.16	1.42
	1325	5.94	65-22-213	1	-3.014	1.36	2.78	9.62	18.5	4.88	1.87
	1325	4.08	66-14-9	0	-1.928		1.41	9.05	22.2	2.64	1.97
	1325	4.08	66-14-203	0	-2.792		1.51	8.41	19.3	2.42	2.16
	1325	4.08	66-15-4	0	-0.526		1.08	23.8	35.3	5.22	2.43
	1325	4.08	66-15-203	0	-0.297		1.28	22.8	33.5	5.93	3.18
	1325	4.08	67-3-5	0	-3.058					4.46	4.04
	1325	4.08	67-3-204	0	-3.910		2.10	8.74	16.9	3.85	1.45
11	1250	4.08	NC8-47A	0	-1.155		1.19	10.1	23.3	3.03	2.53
	1250	4.08	NC8-366	0	-3.843		1.51	6.84	17.5	1.31	1.12
	1275	5.94	233-248	1	-4.636	1.64	1.46	8.18	19.3	1.78	1.45
	1250	4.08	66-14-2	0	-1.521		1.34	9.31	21.3	2.47	2.46
	1250	4.08	66-14-209	0	-2.000		1.38	8.38	20.5	2.23	1.80
	1250	4.08	66-15-5	0	-0.610		0.96	24.1	36.8	5.45	5.02
	1250	4.08	66-15-207	0	-0.377		1.12	23.1	34.9	5.96	3.27
	1250	4.08	67-4-2	0	-0.677		2.35	16.0	18.3	7.20	3.36
	1250	4.08	67-4-205	0	-0.204		2.01	15.8	21.7	7.24	4.59
	1250	4.08	67-5-1	0	+0.138		2.13	9.59	17.0	6.73	6.10
	1250	4.08	67-5-202	0	-0.323		2.18	8.95	15.5	6.78	6.23
	1250	4.08	67-6-4	0	-0.331		1.25	13.5	22.9	6.50	4.35
	1250	4.08	67-6-205	0	-0.611				21.8	6.47	5.54
	1250	4.08	67-7-2	0	-0.352		2.12	13.2	17.8	7.34	4.18
	1250	4.08	67-7-205	0	-0.862		2.61	12.2	15.3	6.65	3.42
	1250	4.08	67-8-2	0	-0.845		2.54	9.14	14.1	6.59	2.71
	1250	4.08	67-8-205	0	-0.736		2.15	9.51	14.9	6.69	4.48
	1250	4.08	67-9-2	0	-0.496		2.28	12.8	17.2	7.19	5.56
	1250	4.08	67-9-205	0	-1.243		1.99	12.8	14.1	7.07	2.21

a. Mean CTE, 25-425 °C.

TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
12	1250	5.85	NC8-43A	1	-1.044			10.3	26.6		1.16
	1250	3.99	NC8-52A	0	-1.308			9.94	24.5	3.08	1.18
	1250	3.99	NC8-365	0	-4.527			5.78	14.9	1.14	1.07
	1250	3.99	233-49A	0	-1.508		0.86	11.4	29.6	3.19	3.02
	1250	3.99	233-266	0	-4.824		1.70	7.28	18.5	1.07	0.87
	1250	3.99	234-347	0	-3.746		2.35		15.9	0.85	0.83
	1250	3.99	65-21-33	0	-2.342		1.78	8.81	17.9	4.50	3.70
	1250	3.99	65-21-225	0	-3.964		2.25	7.69	15.9	3.52	1.98
	1250	3.99	65-22-35	0	-1.886		1.17	8.34	19.1	4.69	3.41
	1250	3.99	65-22-218	0	-2.262		2.16	8.62	19.2	4.82	4.25
	1250	3.99	65-42-14	0	-0.063		2.07			6.70	5.63
	1250	5.85	65-42-24	1	-0.050	1.07	1.25		25.2	7.70	6.10
	1250	3.99	65-42-218	0	-0.195		1.89	14.7	20.9	5.82	5.00
	1250	3.99	67-5-2	0	+0.110		2.14	9.53	17.7	7.05	6.80
	1250	3.99	67-5-205	0	-0.278			9.12	17.2	6.67	4.62
13	1350	3.76	NC8-40A	0	-0.873			9.80	25.4	2.99	2.77
	1325	5.42	NC8-45A	1	-0.580	0.82	1.40	10.9	25.4		1.89
	1350	3.76	NC8-337	0	-3.897		1.81	5.70	15.6	1.06	1.06
	1325	5.42	NC8-359	1	-4.564	1.71	2.23	6.30	17.6		1.00
	1350	3.76	63-16-30	0	-2.017		2.50	13.4	19.0	6.19	1.66
	1350	3.76	63-16-241	0	-2.108			13.5	21.4	5.41	2.13
	1350	3.76	63-19-23	0	-4.720			14.6	31.3	4.03	2.56
	1350	3.76	63-19-219	0	-2.597		0.66	15.4	31.0	4.76	2.05
	1350	3.76	64-13B-39	0	-0.573		1.28	17.4	43.1	4.27	4.12
	1350	3.76	64-13B-216	0	-4.358		0.93	17.7	33.6	2.82	2.33
	1350	3.76	64-17B-26	0	-1.354		1.37	12.3	25.0	5.87	3.38
	1350	3.76	64-17B-220	0	-4.404		1.91	10.6	20.4	4.17	2.16
	1325	5.42	66-6-34	1	+2.782					4.71	2.56
	1325	5.42	66-6-238	1	-2.880		1.44	13.4	18.0	3.69	2.02

a. Mean CTE, 25-425 °C.

TABLE V. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
13	1325	5.42	66-9-27	1	+0.676	1.12	1.08	11.6	30.6	3.51	2.86
	1325	5.42	66-9-229	1	-7.302			5.78	14.2	0.98	0.78
15	1175	4.21	NC8-46A	1	-0.397	0.81	1.16	11.2	29.9		1.74
	1175	4.21	NC8-363	1	-3.468	1.64	1.90	6.57	19.7		0.82
	1150	2.76	65-21-16	0	-1.298		1.72	8.88	21.0	4.47	3.00
	1150	2.76	65-21-212	0	-2.084		2.11	7.80	19.3	3.40	2.90
	1150	2.76	65-21-229	0	-2.411		2.29	7.51	18.1	3.83	2.64
	1150	2.76	65-22-24	0	-1.280		2.07	8.86	21.1	5.02	2.58
	1150	2.76	65-22-216	0	-1.994					4.59	3.12
	1175	4.21	66-9-28	1	-0.680	1.08	1.95	12.2	30.3	3.53	2.38
	1175	4.21	66-9-234	1	-5.377		1.35	5.47	15.4	1.17	0.69
	1175	4.21	66-10-43	1	-1.969	1.45	1.86	11.5	21.0	5.30	1.98
	1175	4.21	66-10-230	1	-1.712			12.0	21.3	5.64	1.96
	1175	4.21	66-12-24	1	+0.429	0.85	0.98	12.9	34.6	3.97	2.75
	1175	4.21	66-12-208	1	-4.986	1.68	2.43	5.88	17.0	1.32	0.77
	1150	2.76	67-5-3	0	+1.057		2.31	9.80	19.3	7.14	4.80
	1150	2.76	67-5-208	0	+0.474		2.37	9.30	18.4	6.77	4.89
	1150	2.76	67-6-6	0	+0.691		1.44	13.0	28.1	6.12	5.70
	1150	2.76	67-6-208	0	+0.521		1.49	13.5	28.1	6.09	4.13
	1150	2.76	67-9-3	0	+0.099		2.04	13.7	20.0	7.33	2.52
	1150	2.76	67-9-208	0	+0.430		2.86	12.7	20.4	7.03	2.99

a. Mean CTE, 25-425 °C.

TABLE VI. GEH-13-15 Experimental Results

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
1	725	1.63	NC8-23A	2	-0.086	0.78	1.63	11.4	34.3	3.42	3.59
	700	1.19	NC8-356	1	-0.132	--	--	6.27	21.3	1.14	0.97
	725	1.63	63-16-21	2	+0.093	1.75	1.95	15.9	29.1	6.43	6.86
			63-16-219	2	+0.048	1.82	2.02	15.2	28.2	6.20	5.66
			66-9-13	2	-0.088	0.89	1.24	12.3	35.0	3.51	3.82
			66-9-213	2	-0.206	2.22	2.91	5.82	18.1	1.25	1.35
			66-12-204	2	-0.188	1.70	1.73	5.80	19.5	1.29	1.10
	625	0.52	66-15-7	0	-0.151	--	--	24.9	42.8	5.57	6.44
			68-1A-1		-0.029		1.58	--	26.6	--	5.63
			68-1A-202		-0.031		1.50	--	30.9	--	4.71
			68-2A-1		-0.032		1.09	--	28.4	--	5.93
			68-2A-202		-0.033		1.55	--	31.6	--	5.61
2	875	3.10	NC8-358	2	-0.904	--	--	--	--	--	--
		3.10	234-304	2	-1.369	--	--	--	--	--	--
		2.46	63-16-42	1	+0.125	--	1.76	13.5	28.4	6.30	6.24
		2.46	63-16-238	1	+0.014	--	1.75	13.4	28.1	5.70	6.73
		3.10	64-17B-32	2	-0.308	1.07	1.34	14.3	33.5	5.63	6.57
		3.10	64-17B-216	2	-0.834	1.24	1.65	11.8	27.9	--	4.95
		2.46	65-18-109	1	+0.325	--	1.65	13.3	31.6	6.23	6.58
		3.10	65-18-298	2	-0.299	--	--	13.7	28.2	--	--
	950	8.85	65-42-2	4	+1.400	1.99	2.16	--	28.8	6.93	2.83
			65-42-200	4	+1.377	1.74	3.14	16.6	31.0	6.78	2.81
			66-4-1	4	-0.593	1.22	1.67	16.3	36.7	6.48	2.41
			66-4-201	4	+0.055	1.13	2.21	16.6	35.9	6.86	2.91
	875	3.10	66-9-17	2	-9.498	0.89	1.21	11.6	35.5	4.21	3.40
			66-9-212	2	-1.072	--	--	--	--	--	--
			66-12-5	2	-0.425	0.92	1.25	11.3	36.0	3.69	3.86
			66-12-203	2	-0.928	--	--	--	--	--	--
3	1000	4.41	NC8-26A	2	-0.700	0.76	1.07	11.2	35.8	3.53	1.26
	1000	4.41	NC8-334	2	-1.979	1.47	2.70	6.87	22.6	--	0.96
	1050	12.31	65-42-9	4	+3.555	1.86	4.25	14.5	31.2	7.04	1.70
			65-42-202	4	+2.885	1.76	3.86	--	--	6.91	1.46
			66-4-2	4	-0.379	1.24	1.20	16.0	37.0	6.52	2.03
			66-9-18	2	-0.957	0.88	1.36	11.3	33.1	3.35	3.11
	1000	4.41	66-9-214		-2.871	2.18	3.28	5.77	18.3	1.18	1.01
			66-10-19		-1.698		--	--	--	5.34	3.17
			66-10-216		-1.423	1.51	2.12	12.2	23.7	5.62	3.14
			66-12-6		-0.554	0.91	1.32	11.3	34.3	3.63	3.46
			66-12-214		-2.765		--	6.62	22.7	1.43	1.00

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TABLE VI. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁻⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
4	1075	5.64	NC8-28A	2	-0.335	0.81	1.31	11.0	32.40	--	2.82
	1075	5.64	65-42-16	2	+1.239	--	--	--	--	8.04	3.59
	1075	5.64	65-42-212	2	+1.115	--	1.50	16.3	32.4	6.89	3.69
	1075	4.57	66-4-18	1	+0.196	--	1.55	14.2	32.5	6.14	4.66
	1075	5.64	66-9-44	2	-0.245	1.27	1.41	11.0	30.2	--	2.72
	1075	5.64	66-9-215	2	-6.131	--	--	5.62	18.3	1.19	0.91
	1050	9.28	66-15-3	3	+0.915	--	--	25.3	43.2	--	--
	1050	9.28	66-15-205	3	+1.661	0.85	2.69	24.2	43.5	6.10	1.51
	1050	9.28	67-1-10	3	+4.298	1.36	4.35	11.7	27.9	5.30	0.88
	1050	9.28	67-1-206	3	+0.184	1.42	4.69	10.5	25.1	4.78	1.29
	1075	4.57	67-4-1	1	+0.362	--	1.34	15.5	23.8	7.26	3.10
			67-4-202		+0.519	--	3.12	14.6	24.2	6.92	1.34
			67-6-1		+0.423	--	1.42	15.0	35.1	5.89	5.39
			67-6-202		+0.771	--	1.67	12.8	31.3	5.98	4.55
			67-8-1		+0.070	--	3.12	8.91	18.0	6.37	2.51
			67-8-202		+0.110	--	3.11	9.05	18.8	6.77	2.42
5	1125	6.60	NC8-29-A	2	+1.174	--	--	10.9	31.1	3.13	3.03
	1125	6.60	NC8-340	2	-5.813	1.54	1.52	6.59	20.4	1.44	1.11
	1075	6.00	234-144	2	+0.298	0.76	1.56	12.4	30.5	3.66	2.82
	1075	6.00	234-296	2	-6.162	--	--	5.92	17.4	0.99	0.71
	1100	6.41	63-23-4	2	-1.487	--	0.93	--	--	3.25	2.33
			63-23-202	2	-5.761	1.28	2.03	8.31	37.2	1.83	1.17
			63-29-6		-3.544	--	0.71	14.6	40.0	3.06	3.14
			63-29-201		-9.365	--	1.30	--	--	1.99	1.25
	1125	6.60	65-22-8	2	-1.718	1.34	3.27	9.67	20.1	--	1.61
	1125	5.34	65-22-29	1	-2.013	--	--	8.38	18.9	5.21	1.82
	1125	5.34	65-22-210	1	-3.041	--	4.05	8.74	19.4	4.32	1.57
	1125	5.34	66-15-6	1	-0.302	--	1.44	24.6	39.8	5.48	1.92
			66-15-206		-0.039	--	1.46	22.1	36.7	5.75	2.18
			67-3-3		-1.629	--	--	--	--	4.84	1.85
			67-3-201		-4.009	--	3.64	8.49	19.2	3.88	1.26
	1100	2.59	68-1A-7	0	-1.240	--	0.93	--	--	--	5.05
			68-1A-203		-1.810	--	1.00	--	26.8	--	3.48
			68-2A-2		-1.230	--	0.99	--	28.6	--	5.70
			68-2A-204		-2.012	--	0.92	--	28.4	--	4.62
6	1200	7.52	NC8-30A	2	+1.555	0.82	1.08	10.8	30.4	--	3.13
			NC8-342		-6.954	1.50	1.91	6.30	20.6	--	0.93
			233-45		+0.297	0.72	0.81	12.8	32.9	3.41	3.10
			234-146		+3.388	0.78	1.23	--	34.2	3.67	3.18
			234-216		-10.045	--	--	5.74	18.0	1.10	1.05
			65-21-27		-1.592	--	--	9.87	20.2	--	1.22
			65-22-9		-2.394	1.32	3.25	9.79	18.6	--	1.26
			65-22-223		-2.997	1.23	4.55	--	20.3	--	0.94
		6.08	66-14-11	1	-1.706	--	1.63	9.17	24.3	2.31	--
		6.08	66-14-211	1	-3.018	--	1.77	8.40	21.7	1.98	2.28
		2.95	66-15-9	0	-0.436	--	1.25	--	35.1	--	2.09

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TABLE VI. (Con'd)

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Capsule Position	Temp., °C	Fluence, $^{21}\text{nvt} \times 10$ ($E > 0.18 \text{ MeV}$)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0, \%$	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						$\text{psi} \times 10^{-6}$		$\text{ohm-cm} \times 10^4$		$10^{-6} \text{ per } ^\circ\text{C} (a)$	
						Initial	Final	Initial	Final	Initial	Final
7	1250	3.31	NC8-51A	0	-1.287		1.04		21.8		2.83
			NC8-260		-0.793		1.06		--		--
			66-4-9		-0.719		1.48	15.6	26.2	6.77	5.57
			66-4-205		-0.180		1.18	16.6	27.7	6.76	6.93
			66-9-35		-1.309		1.42		23.3		1.07
			66-9-224		-5.289		--		14.0		0.88
			66-15-10		-0.493		1.26		33.6		2.84
			66-15-209		-0.243		1.49		34.1		3.84
			67-4-3		-0.397		--		17.2	7.19	2.94
			67-4-208		-0.298		1.86		19.9		5.59
			67-5-6		-0.037		2.25		14.9		4.31
			67-6-5		+0.092		0.82		--	6.75	6.25
			67-8-5		-0.200		2.49		--		3.18
			67-8-208		-0.196		1.89		17.3	6.49	5.60
			67-24-201		-0.789		1.14		--		5.93
			68-1A-4		-1.776		--		24.9		4.49
			68-1A-205		-2.782		0.86		25.7		4.09
			68-2A-4		-1.783		0.90		--		5.29
			68-2A-206		-2.827		1.08		28.3		3.61
8	1275	8.92	NC8-32A	2	-0.487	0.77	1.06	10.9	26.8	3.32	3.10
			NC8-344		-4.224	1.52	1.61	6.57	17.6	--	0.58
			233-65A		-0.568	0.75	1.10	12.6	28.0	--	3.18
			233-262		-6.294	1.59	1.33	7.83	18.8	--	0.84
			61-70-16		-0.231	0.50	0.59	15.5	38.5	3.56	2.96
			61-70-222		-6.389	1.50	1.28	7.80	20.7	1.52	0.55
			66-4-4		-1.328	1.25	1.43	17.1	26.9	6.60	4.32
		7.34	66-4-203	1	-0.899	1.10	1.44	16.7	26.9	6.67	4.41
			66-15-1		-0.484	--	1.57	25.3	38.1	5.22	4.07
			66-15-201		-0.322	--	--	--	36.0	5.27	6.52
			67-6-2		-0.485	--	1.28	14.54	28.3	5.75	5.64
			67-6-3		-0.817	--	1.26	14.49	27.6	6.43	4.31
9	1300	9.52	NC8-33A	2	-0.533	0.88	1.05	9.92	39.3	--	3.16
		9.52	NC8-364		-5.058	--	--	6.27	17.0	1.51	1.18
		9.38	225-32		+4.472	0.59	0.58	17.4	43.1	--	4.26
			63-23-6		-2.091	0.58	0.64	14.0	30.6	3.41	3.10
			63-23-205		-4.895	1.39	1.49	8.35	18.8	1.89	1.78
			63-29-7		-4.331	--	0.75	14.8	34.3	3.05	2.79
			63-29-207		-8.212	--	1.09	--	--	1.76	1.42
		9.52	65-18-121		+0.279	1.30	1.70	14.5	22.3	6.58	1.93
		9.38	65-29-3		+1.739	1.25	1.47	13.5	31.5	2.79	2.21
			65-29-209		-4.50	--	--	--	--	--	--
			66-6-33		+4.760	--	2.88	--	--	--	--
		9.52	66-9-217		-7.080	--	--	--	--	--	--

TABLE VI. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
10	1325	8.03	NC8-25A	1	+0.133	--	0.93	--	--	--	--
		8.03	NC8-331	1	-7.014	--	1.80	--	--	1.26	1.40
		9.89	NC8-347	2	-6.809	1.60	1.68	6.22	16.2	--	0.93
		8.03	65-21-18	1	-2.180	--	1.70	8.71	16.7	4.20	1.98
		9.89	65-22-17	2	-2.015	--	--	9.77	17.5	5.16	1.25
		9.89	65-22-213	2	-3.183	--	--	9.62	16.3	4.88	1.34
		8.03	66-14-9	1	-1.860	--	1.50	9.05	22.5	2.64	2.74
		8.03	66-14-203	1	-3.138	--	1.61	8.41	20.2	--	--
			66-15-4		-0.531	--	1.20	23.8	32.5	5.22	2.58
			66-15-203		-0.026	--	1.85	22.8	33.7	5.93	1.51
	1300		67-3-5		-2.344	--	--	--	--	--	--
			67-3-204		-4.457	--	2.80	8.74	16.6	3.85	1.33
		3.95	68-1A-6	0	-1.872	--	1.08		25.3		5.32
			68-1A-207		-2.773	--	1.03		22.6		4.85
			68-2A-5		-1.699	--	0.84		28.5		4.93
			68-2A-208		-3.108	--	0.94		25.7		4.80
11	1300	8.05	NC8-47A	1	-1.243	--	0.91	10.1	22.0	3.03	3.19
		8.05	NC8-366	1	-5.167	--	1.41	6.84	18.8	1.31	1.19
		9.91	233-248	2	-5.774	1.64	1.00	8.18	20.3	1.78	1.01
		8.05	66-14-2	1	-2.019	--	1.36	9.31	20.8	2.47	2.37
			66-14-209		-2.638	--	1.61	8.38	20.2	2.23	1.20
			66-15-5		-0.694	--	0.98	24.1	36.3	5.45	3.48
			66-15-207		-0.231	--	1.38	23.1	32.6	5.96	2.49
			67-4-2		+0.073	--	2.95	16.0	18.3	7.20	2.44
			67-4-205		+0.068	--	1.71	15.8	20.7	7.24	1.34
			67-5-1		+0.074	--	--	9.59	16.4	6.73	3.11
			67-5-202		-0.557	--	3.02	8.95	15.2	6.78	4.70
			67-6-4		-0.855	--	1.30	13.5	22.3	6.50	5.21
			67-6-205		-1.270	--	--	--	20.9	6.47	4.64
			67-7-2		-0.581	--	3.03	13.2	16.2	7.34	1.20
			67-7-205		-0.992	--	3.78	12.2	14.2	6.65	1.64
			67-8-2		-0.805	--	--	9.14	13.1	6.59	1.42
			67-8-205		-1.024	--	2.78	9.51	15.4	6.69	2.60
			67-9-2		-0.687	--	2.81	12.8	16.1	7.19	3.74
			67-9-205		-1.116	--	2.88	12.8	15.3	7.07	1.38
12	1275	9.72	NC8-43A	2	-0.778	0.84	1.02	10.3	24.5	--	3.12
	1275	7.86	NC8-52A	1	-0.680	--	1.23	9.94	27.9	3.08	2.69
			NC8-365		-5.906	--	2.37	5.78	15.7	1.14	1.40
			233-49A		-1.454	--	0.98	11.4	27.5	3.19	2.60
			233-266		-6.247	--	1.56	7.28	19.8	1.07	1.31
	1335	3.87	65-21-28	2	-2.048	1.11	1.44	9.89	17.3	--	2.08
			65-21-222		-4.173	1.46	3.29	8.93	16.6	--	1.18
			65-22-13		-1.933	--	--	8.69	17.6	4.90	1.31
	1275	7.86	65-22-35	1	-2.264	--	2.20	8.34	17.3	4.69	3.92
			65-22-218		-3.219	--	1.63	8.62	15.7	4.82	2.50
			65-42-14		-0.250	--	2.11	--	--	6.70	3.86

TABLE VI. (Con'd)

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Capsule Position	Temp., °C	fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
34	12	1275	65-42-24	2	+0.427	1.07	2.59	--	--	7.70	2.45
	(contd)	1275	65-42-218	1	-0.211	--	1.64	14.7	20.3	5.82	3.94
		1275	67-5-2	1	+0.088	--	1.61	9.53	16.6	7.05	5.57
		1275	67-5-205	1	-0.478	--	1.57	9.12	16.1	6.67	4.27
	13	1325	NC8-40A	1	+2.691	--	0.84	--	--	--	--
		1300	NC8-45A	2	+3.709	0.82	0.82	--	--	--	--
		1325	NC8-337	1	-7.442	--	2.28	--	--	1.06	1.70
		1300	NC8-359	2	-7.484	1.71	2.42	--	--	--	--
		1325	63-16-241	1	+0.824	--	2.05	--	--	--	--
			63-19-23		-4.511	--	0.47	14.6	46.7	4.03	2.60
			63-19-219		+2.819	--	--	--	--	--	--
			64-17B-26		+3.326	--	1.23	--	--	--	--
			64-17B-220		-2.520	--	1.60	10.6	29.7	4.17	2.58
	1300	9.08	66-6-34	2	-7.015	--	--	--	--	--	--
			66-6-238		-2.363	--	--	13.4	22.6	3.69	1.71
			66-9-27		+9.511	1.12	3.82	--	--	3.51	5.41
	14	1200	NC8-27A	0	-0.715		1.04		27.5		3.20
			NC8-273		-3.812		2.31		17.5		0.91
			225-73		+1.138		0.90		36.6		5.75
			225-238		-6.373		1.35		27.7	2.65	3.31
			233-79		-1.469		0.96		25.5		3.19
			233-295		-4.344		1.63		18.3		1.05
			234-118		+0.031		1.15		28.9		4.20
			234-342		-6.521		2.59		13.3		0.91
	1175	7.29	64-13B-213	2	-3.021	0.55	0.59	20.0	54.2	3.24	3.56
		6.03	65-21-19	1	-1.865		--	8.97	19.7	4.19	1.19
		6.03	65-21-232	1	-4.327		--	7.86	16.9	3.44	0.72
	1200	3.28	66-4-22	0	-0.331		1.29		28.3		6.28
	1175	7.29	66-10-23	2	-1.622	1.37	4.83	11.9	18.6	5.82	1.21
			66-10-229	2	-1.761		5.08	12.1	18.2	--	1.41
	1200	3.28	67-1-8	0	+0.506		3.57		17.7		3.31
			67-1-203		-1.276		--		18.7		2.81
			67-24-1		-1.199		1.24		31.7		4.59
			67-24-202		-0.684		1.18		35.0		5.25
	15	1300	NC8-46A	2	+3.386	0.81	1.18	11.2	33.2	--	2.88
		9.91	NC8-363	2	-6.208		--	6.57	20.6	--	0.72
		8.05	65-21-16	1	-1.881	--	3.17	8.88	19.6	4.47	1.54
			65-21-212		-3.687	--	--	7.80	19.3	3.40	1.44
			65-21-229		-3.977	--	2.60	7.51	18.9	3.83	1.53
			65-22-24		-1.975	--	--	8.86	19.2	5.02	1.60
			65-22-216		-3.098	--	1.23	--	--	4.59	0.82

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TABLE VI. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
15 (contd)	1300	9.91	66-9-28	2	+4.093	1.08	3.35	12.2	41.3	3.53	3.54
			66-9-234		-8.617	--	--	--	--	1.17	1.13
			66-10-43		-2.065	1.45	5.15	11.5	21.5	5.30	1.19
			66-10-230		-1.463	--	5.22	12.0	21.8	5.64	0.88
			66-12-24		+6.089	0.85	6.24	12.9	43.5	3.97	0.89
		8.05	66-12-208	1	-7.618	--	--	--	--	--	--
			67-5-3		+0.630	--	3.10	9.80	19.0	7.14	1.83
			67-5-208		-0.345	--	4.78	9.30	18.1	6.77	1.70
			67-6-208		-0.622	--	--	13.5	27.0	6.09	2.39
			67-9-3		-0.561	--	5.13	13.7	20.2	7.33	1.59
			67-9-208		-0.521	--	4.78	12.7	19.2	7.03	1.69

TABLE VII. GEH-13-17 Experimental Results

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
1	725	2.36	NC8-23A	3	-0.146	0.78	1.39	11.4	31.4	3.42	2.90
		1.92	NC8-356	2	-0.216	--	1.46	6.27	19.4	1.14	1.02
		2.36	63-16-21	2	+0.126	1.75	1.86	15.9	27.1	6.43	6.33
			63-16-219	3	+0.063	1.82	1.93	15.2	25.9	6.20	5.96
			66-9-13		-0.135	0.89	1.24	12.3	32.4	3.51	2.76
			66-9-213		-0.352	2.22	2.64	5.82	16.9	1.25	0.72
	700		66-12-204		-0.297	1.70	3.24	5.80	17.9	1.29	0.58
		1.25	66-15-7	1	-0.122		--	24.9	41.3	5.57	5.74
			68-1A-1		-0.022		1.43	--	24.9	--	5.30
			68-1A-202		-0.054		1.17	--	29.9	--	4.69
			68-2A-1		-0.023		1.06	--	34.3	--	5.05
			68-2A-202		-0.052		1.34	--	29.5	--	4.29
2	900	4.51	NC8-358	3	-1.742		--	--	--		--
	900	4.51	234-304	3	-2.420		--	--	--		--
	875	3.87	63-16-42	2	-0.037	--	1.72	13.5	25.5	6.30	3.59
	875	3.87	63-16-238	2	-0.269	--	1.42	13.4	25.4	5.70	4.21
	900	4.51	64-17B-32	3	-0.634	1.07	1.32	14.3	29.1	5.63	4.87
	900	4.51	64-17B-216	3	-1.535	1.24	1.30	11.8	24.4	--	3.81
	875	3.87	64-18-109	2	+0.470	--	1.61	13.3	27.4	6.23	5.12
	900	4.51	65-18-298	3	-0.769	1.43	1.46	13.7	25.4	--	4.06
	950	10.26	65-42-2	6	+1.643		--	--	27.0	6.93	2.03
			65-42-200	6	+1.578	1.74	3.10	16.6	28.3	6.78	2.37
			66-4-1	6	-0.880	1.22	1.53	16.3	33.5	6.48	2.06
			66-4-201	6	-0.163	1.13	2.40	16.6	32.9	6.96	2.24
	900	4.51	66-9-17	3	-0.761	0.89	1.46	11.6	31.7	4.21	2.68
			66-9-212	3	-2.086	--	--	--	--		--
			66-12-5	3	-0.618	0.92	1.21	11.3	31.8	3.69	2.87
			66-12-203	3	-1.718	--	--	--	--		--
3	1000	6.40	NC8-26A	3	-0.215		--	11.2	32.0	3.53	2.15
	1000	6.40	NC8-334	3	-3.220	1.47	2.70	6.87	21.3	--	0.76
	975	10.80	65-22-6	6	+1.263		--	--	24.6	--	1.12
	1050	14.30	65-42-9	6	+4.668	1.86	3.75	14.5	30.3	7.04	1.58
	1050	14.30	65-42-202	6	+3.896	1.76	3.67		31.7	6.91	1.78
	1050	14.30	66-4-2	6	+0.114	1.24	1.18	16.0	35.1	6.52	1.65
	1000	6.40	66-9-18	3	-0.784		--	11.3	30.4	3.35	2.38
			66-9-214		-4.958		--	5.77	17.3	1.18	0.58
			66-10-19		-2.020	1.43	3.25	12.1	21.0	5.34	1.77
			66-10-216		-1.783		--	12.2	21.3	5.62	1.84
			66-12-6		+0.032	0.91	1.15	11.3	31.2	3.63	2.34
			66-12-214		-4.512		--	6.62	21.7	1.43	0.75

TABLE VII. (Con'd)

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Capsule Position	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^4$ ($E > 0.18 \text{ MeV}$)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0, \%$	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi $\times 10^{-6}$		ohm-cm $\times 10^4$		10^{-6} per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
4	1075	8.28	NC8-28A	3	+2.185	0.81	1.23	11.0	31.4	--	--
			65-42-16		+1.340	0.98	3.36	--	23.4	8.04	2.38
			65-42-212		+0.949	--	3.06	16.3	23.7	6.89	2.20
	1100	7.21	66-4-18	2	-0.460	--	1.09	14.2	29.7	6.14	2.63
	1075	8.28	66-9-44	3	+4.209	1.27	0.87	11.0	36.2	--	2.83
	1075	8.28	66-9-215	3	-8.616	2.24	2.40	5.62	19.9	1.19	1.01
	1075	11.92	66-15-3	5	+1.399	0.85	2.64	25.3	39.9	5.34	0.86
			66-15-205		+2.312	0.85	2.54	24.2	40.0	6.10	0.84
			67-1-10		+6.014	--	--	11.7	26.9	5.30	0.87
			67-1-206		+1.053	1.42	3.46	10.5	24.1	4.78	0.99
	1100	7.21	67-4-1	2	+0.755	--	2.78	15.5	22.3	7.26	1.74
			67-4-202		+0.881	--	4.03	14.6	22.7	6.92	1.92
			67-6-1		+0.029	--	2.23	15.0	31.1	5.89	3.09
			67-6-202		+0.127	--	1.87	12.8	26.5	5.98	2.55
			67-8-1		-0.039	--	5.69	8.91	17.1	6.37	1.29
			67-8-202		-0.177	--	2.99	9.05	17.4	6.77	1.30
5	1125	9.71	NC8-29A	3	+6.547	0.81	0.96	10.9	35.2	3.13	3.11
	1100	9.11	234-144	4	+4.160	0.76	0.99	12.4	33.7	3.66	2.67
	1100	9.11	234-296	4	-9.858	1.78	2.80	5.92	18.1	0.99	0.88
	1125	9.71	65-22-8	3	-0.910	1.34	4.67	9.67	18.9	--	0.82
	1125	8.45	65-22-29	2	-1.527	--	--	8.38	17.5	5.21	1.02
	1125	8.45	65-22-210	2	-2.986	--	5.08	8.74	16.9	4.32	0.84
	1075	10.16	66-10-24	4	-0.757	1.43	2.78	11.2	22.5	5.17	1.03
			66-10-226		-0.514	--	2.63	--	21.5	5.71	0.82
			66-14-4		+0.189	--	--	--	28.4	--	2.14
			66-14-204		-1.818	1.24	1.94	8.85	26.8	2.26	2.05
	1125	8.45	66-15-6	2	-0.201	--	1.99	24.6	35.1	5.48	1.15
			66-15-206		+0.375	--	2.22	22.1	34.2	5.75	1.34
			67-3-3		-0.085	--	3.35	--	21.5	4.84	1.21
			67-3-201		-4.281	--	4.12	8.49	19.0	3.88	1.30
		5.70	68-1A-7		-1.230	--	--	--	26.4	--	2.09
			68-1A-203		-3.330	--	1.17	--	25.1	--	0.93
			68-2A-2		-1.165	--	1.45	--	26.0	--	2.23
			68-2A-204		-3.397	--	--	--	26.2	--	1.68
6	1200	11.08	233-45	4	+4.921	0.72	0.73	12.8	38.2	3.41	3.37
			234-216		-12.561	1.83	2.07	5.74	21.8	1.10	1.32
			65-21-27		-0.161	--	3.80	9.87	20.5	--	1.29
			65-22-9		-0.907	1.32	4.51	9.79	18.2	--	--
			65-22-223		-2.520	1.23	4.43	--	19.8	--	0.89
		9.64	66-14-11	3	-0.324	--	1.49	9.17	24.6	2.31	2.51
		9.64	66-14-211	3	-2.727	--	1.15	8.40	22.6	1.98	1.92
		6.51	66-15-9	2	-0.439	--	1.12	--	31.4	--	1.48

TABLE VII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
38	6	1150	5.90	67-7-1	2	-0.236	2.79		18.9	7.30	1.30
	(contd)			67-7-202		-0.398	4.60	12.4	16.9	7.13	1.57
				67-9-1		-0.211	5.65	12.6	15.8	7.25	1.09
				67-9-202		-0.773	7.07	12.4	15.1	7.42	0.85
	7	1250	7.31	NC8-S1A	1	+2.104	0.84		25.2		3.03
				NC8-260		+4.100	0.70		29.1		2.99
				66-4-9		-1.752	1.53	15.6	22.6	6.77	2.62
				66-4-205		-0.855	1.38	16.6	25.7	6.76	3.69
				66-9-35		+3.233	0.64		29.7		3.35
				66-9-224		-8.977	4.99		15.2		1.07
				66-15-10		-0.516	--		29.2		1.42
				66-15-209		+0.038	--		31.2		1.40
				67-4-3		+2.263	3.39		18.4	7.19	1.57
				67-4-208		+1.188	3.31		21.1		1.14
				67-5-6		+0.044	--		14.1		1.01
				67-6-5		-0.616	--		23.2	6.75	3.31
				67-8-5		+0.269	--		14.6		1.09
				67-8-208		-0.679	3.68		15.3	6.49	1.44
				67-24-201		-0.954	1.22		34.7		3.32
				68-1A-4		-1.061	--		24.0		1.89
				68-1A-205		-3.840	2.88		22.5		1.44
				68-2A-4		-0.678	--		25.4		1.91
				68-2A-206		-3.597	--		24.1		1.45
	8	1275	13.27	NC8-32A	4	+0.367	0.77	0.87	10.9	3.32	2.44
		1275	13.27	NC8-344	4	-5.231	--	--	6.57	--	0.88
		1175	6.29	233-26	3	-1.494	0.73	0.93	13.1	3.55	3.28
		1275	13.27	233-65A	4	+0.709	0.75	0.90	12.6	--	2.77
		1175	6.29	233-210	3	-5.087	1.68	2.68	7.38	1.69	1.20
		1275	13.27	233-262	4	-7.375	--	--	7.83	--	1.09
			13.27	66-4-4	4	-1.815	1.25	1.67	17.1	6.60	2.58
			11.69	66-15-1	3	-0.347	--	1.24	25.3	5.22	2.18
				66-15-201	3	-0.154	--	--	--	5.27	2.12
				67-6-2	3	-0.886	--	1.15	14.5	5.75	4.68
				67-6-3	3	-1.215	--	1.20	14.5	6.43	2.36
	9	1300	14.17	NC8-33A	4	+0.273	0.88	1.21	9.92	--	2.43
		1300	14.17	NC8-364	4	-6.136	1.46	1.75	6.27	1.51	1.03
		1300	6.31	225-247	2	-5.522		1.00		2.54	3.25
		1325	6.51	63-36-2	2	-1.785		0.82		2.78	2.97
		1300	14.17	65-18-121	4	+1.277	1.30	1.76	14.5	6.58	1.83
		1275	8.64	65-21-33	2	-2.174		2.61	8.81	4.50	1.68
		1275	8.64	65-21-225		-4.396		--	7.69	3.52	1.30

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TABLE VII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
9 (contd)	1300	6.31	65-22-224	2	-3.144		3.49		15.9	--	1.39
	1300	14.03	65-29-3	4	+3.529	1.25	1.26	13.5	30.8	2.79	2.56
	1325	6.51	65-37-9	2	-2.268		0.97		21.8	2.48	1.86
	1300	6.31	65-42-122		+0.287		3.14	16.8	20.7	6.89	3.90
	1300	6.31	66-4-10		-0.544		1.29	16.5	26.1	6.54	5.08
10	1325	6.62	65-21-9	2	-2.381		--		15.5	--	2.01
	1325	12.79	65-21-18	2	-1.811	--	3.15	8.71	16.9	4.20	1.29
	1325	14.65	65-22-17	3	-1.733	1.40	4.18	9.77	16.4	5.16	0.99
	1325	14.65	65-22-213	3	-3.044	1.36	4.19	9.62	16.1	4.88	0.82
	1300	6.42	65-29-5	2	+1.128		1.50	13.2	25.7	2.78	2.82
	1300	6.42	65-29-210	2	-4.498		--	10.5	19.4	2.10	1.56
	1325	12.79	66-14-9	2	-1.337	--	--	9.05	23.0	2.64	2.11
	1325	12.79	66-14-203	2	-2.786	--	1.45	8.41	20.7	2.42	2.12
	1325	12.79	66-15-4	2	-0.466		1.43		33.1	5.22	1.47
	1325	12.79	66-15-203	2	+0.409	--	1.47	22.8	31.0	5.93	1.16
	1325	12.79	67-3-5	2	-1.690	--	--	--	17.3	4.46	1.29
	1325	12.79	67-3-204	2	-4.685	--	3.45	8.74	15.6	3.85	0.96
		8.71	68-1A-6	2	-1.626		1.39		22.4		2.72
			68-1A-207	2	-3.707		1.29		22.1		2.76
			68-2A-5	2	-1.613	--			23.4		3.00
			68-2A-208	2	-3.805		1.18		22.4		2.33
11	1300	12.74	NC8-47A	3	-0.350	--	0.96	10.1	23.5	3.03	2.64
	1300	12.74	NC8-366	3	-6.543	--	0.96	6.84	15.4	1.31	1.10
	1300	14.60	233-248	4	-6.988	1.64	1.23	8.18	17.7	1.78	1.16
	1300	12.74	66-14-2	3	-2.328	--	1.26	9.31	18.7	2.47	2.24
			66-14-209		-2.981	--	1.50	8.38	19.4	2.23	1.88
			66-15-5		-0.701	--	1.02	24.1	34.8	5.45	2.33
			66-15-207		-0.070	--	1.73	23.1	32.4	5.96	1.31
			67-4-2		+1.660	--	2.31	16.0	22.4	7.20	1.96
			67-4-205		+1.184	--	--	15.8	21.3	7.24	2.24
			67-5-1		+0.067	--	2.77	9.59	14.6	6.73	2.32
			67-5-202		-0.774	--	2.64	8.95	13.0	6.78	2.20
			67-6-4		-0.997	--	1.36	13.5	23.4	6.50	3.16
			67-6-205		-1.516	--	1.79	--	22.2	6.47	2.45
			67-7-2		-0.269	--	4.01	13.2	16.4	7.34	1.20
			67-7-205		-0.551	--	--	12.2	15.1	6.65	1.06
			67-8-2		-0.052	--	4.10	9.14	13.1	6.59	1.00
			67-8-205		-1.025	--	3.48	9.51	14.5	6.69	1.30
			67-9-2		-0.684	--	3.89	12.8	13.2	7.19	1.44
			67-9-205		-0.717	--	5.02	12.8	14.1	7.07	0.86

TABLE VII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
12	1275	14.22	NC8-43A	4	+0.365	0.84	0.69	10.3	23.1	--	2.62
	1275	12.36	NC8-52A	3	+0.692	--	0.91	9.94	23.6	3.08	2.80
			NC8-365		-6.777	--	--	5.78	18.0	1.14	1.05
			233-49A		-0.892	--	0.74	11.4	27.7	3.19	2.86
			233-266		-7.133	--	1.40	7.28	19.0	1.07	1.32
			234-347		-8.701	--	2.06	--	14.0	0.85	0.96
	1300	14.31	65-21-28	4	-1.731	1.11	3.23	9.89	17.2	--	1.16
	1300	14.31	65-21-222	4	-4.163	1.46	3.42	8.93	17.0	--	0.88
	1325	12.45	65-22-13	3	-1.578	--	3.99	8.69	15.9	4.90	0.85
	1275	12.36	65-22-35		-2.271	--	2.97	8.34	14.0	4.69	1.33
		12.36	65-22-218		-3.339	--	3.82	8.62	15.5	4.82	1.12
		12.36	65-42-14		+0.196	--	--	--	19.0	6.70	2.30
		14.22	65-42-24	4	+1.611	1.07	2.24	--	21.7	7.70	2.07
		12.36	65-42-218	3	+0.155	--	2.30	14.7	20.4	5.82	2.34
		12.36	67-5-2		+0.059	--	2.85	9.53	14.7	7.05	2.69
		12.36	67-5-205		-0.664	--	2.84	9.12	14.4	6.67	2.08
13	1225	7.47	NC8-27A	2	+2.034		0.88		26.9		2.95
			NC8-273		-6.048		1.73		16.9		0.89
			225-73		+13.192		0.31		57.2		5.77
			225-238		-2.975		0.58		50.4	2.65	3.73
			233-79		+1.938		0.68		34.2		4.32
			233-295		-6.547		1.57		16.4		1.21
			234-118		+2.362		0.77		27.5		3.38
			234-342		+10.001		--		15.9		1.52
	1200	10.22	65-21-19	3	-0.235	--	2.77	8.97	20.9	4.19	1.17
			65-21-232	3	-3.884	--	3.09	7.86	17.9	3.44	0.93
	1225	7.47	66-4-22	2	-1.129		1.33		26.0		4.19
	1200	11.48	66-10-23	4	+0.180	1.37	3.80	11.9	19.0	5.82	0.67
			66-10-229	4	+0.116		3.68	12.1	18.9	--	0.85
	1225	7.47	67-1-8	2	+2.673		3.27		18.2		1.80
			67-24-1		-0.478		1.04		19.6		3.40
			67-24-202		-1.134		1.30		33.0		3.75
14	1400	3.23	NC8-48A	0	-1.260		0.76		17.3		3.23
			NC8-336	0	-1.935		1.49		9.61		1.17
		3.71	225-60	1	-8.265		0.84		18.5		3.88
			233-85		-1.996		0.73		17.3		3.33
			233-309		-2.954		1.56		11.6		--
			234-76		-1.704		0.52		24.6		3.53
			234-253		-2.871		2.30		9.06		0.69
			65-21-35		-1.962	1.13	1.44		--		4.47
			65-21-226		-2.265	1.42	1.38		12.5		3.46
			65-22-41		-2.124		1.47		13.0		4.87
			65-22-225		-2.474	1.31	1.24		12.6		4.65

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TABLE VII. (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
14 (contd)	1400	3.71	65-42-18	1	-0.928		1.72		16.4		6.89
			66-4-16		-1.629		1.15		18.9		6.42
			66-4-209		-1.438		0.90		19.1		6.05
			66-10-20		-2.986		1.08		13.2		4.84
			66-10-235		-2.436		--		--		--
			66-14-1		-2.318		1.09		14.2		2.34
			67-1-11		-0.690		1.47		15.4		5.58
			67-1-202		-1.543		1.62		13.4		4.96
15	1175	9.92	NC8-363	4	-7.138	1.64	0.98	6.57	30.8	--	1.52
	1150	8.47	65-21-16	3	-0.574	--	4.19	8.88	22.9	4.47	1.30
			65-21-212	3	-3.606	--	3.60	7.80	19.7	3.40	1.15
			65-21-229	3	-3.456	--	3.69	7.51	22.0	3.83	1.17
	850	6.08	65-22-1	6	-1.118	--	1.63	--	20.4	--	4.71
	1150	8.47	65-22-24	3	-0.871	--	4.07	8.86	22.5	5.02	0.98
	850	6.08	65-22-201	6	-2.117	--	1.98	--	18.9	--	3.64
	1150	8.47	65-22-216	3	-2.541	--	--	--	20.3	4.59	0.92
	950	4.66	66-7-4	4	-0.470	--	--	22.8	14.6	--	--
			66-7-200	4	-4.685	--	4.92	6.55	13.2	5.15	0.85
	1175	9.92	66-10-43	4	-0.806	1.45	4.21	11.5	23.4	5.30	1.01
			66-10-230	4	+0.035	--	3.53	12.0	24.0	5.64	0.87
	1150	8.47	67-5-3	3	+1.085	--	4.35	9.80	19.6	7.14	1.32
			67-5-208	3	+0.407	--	4.61	9.30	19.9	6.77	1.35
			67-6-208	3	-0.534	--	2.33	13.5	29.6	6.09	1.91
	975	4.50	67-8-4	1	+0.506	2.05	2.81	--	17.6	--	5.36
	1150	8.47	67-9-3	3	+0.805	--	4.26	13.7	23.5	7.33	1.47
			67-9-208	3	+0.862	--	5.13	12.7	21.1	7.03	1.26

TABLE VIII. GEH-13-421 Experimental Results

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
3	750	4.18	NC8-23A	5	-0.555	0.78	1.41	11.4	32.8	3.42	3.15
	725	3.74	NC8-356	4	-1.087	--	2.53	6.27	20.6	1.14	0.99
	750	4.18	63-16-21	5	-0.004	1.75	1.78	15.9	27.4	6.43	5.16
			63-16-219	5	-0.171	1.82	1.85	15.2	25.9	6.20	5.46
			66-9-13	5	-0.564	0.89	1.343	12.3	32.6	3.51	3.15
			66-9-213	5	-1.433	2.22	3.56	5.82	17.8	1.25	1.02
			66-12-204	5	-1.014	--	--	5.80	19.2	1.29	1.13
	725	3.07	66-15-7	3	+0.078	--	--	24.9	44.9	5.57	5.59
			68-1A-1	3	-0.334	--	1.50	--	30.2	--	5.51
			68-1A-202	3	-0.625	--	1.06	--	34.2	--	4.62
4	875	7.03	NC8-358	5	-4.187	1.68	2.78	--	19.5	1.32	0.84
			234-304	5	-5.759	--	--	6.02	18.4	0.95	0.56
	875	6.39	63-16-42	4	-0.886	--	3.04	13.5	24.0	6.30	2.37
			63-16-238	4	-1.546	--	2.96	13.4	23.2	5.70	2.16
			65-18-109	4	+0.588	--	2.29	13.3	25.6	6.23	2.94
	875	7.03	65-18-298	5	-1.999	1.43	2.50	13.7	24.3	--	2.51
	925	12.78	65-42-2	7	+2.466	1.99	3.11	--	29.9	6.93	2.03
			65-42-200	7	+2.266	1.74	3.01	16.6	32.0	6.78	2.12
			66-4-1	7	-0.899	1.22	2.48	16.3	33.9	6.48	2.01
			66-4-201	7	-0.089	1.13	2.47	16.6	34.4	6.86	1.89
	875	7.03	66-9-17	5	-0.320	0.89	1.37	11.6	28.9	4.21	2.60
			66-9-212	5	-5.143	--	3.80	--	17.1	1.25	0.72
			66-12-5	5	+0.202	0.92	1.31	11.3	31.1	3.69	2.59
			66-12-203	5	-4.576	--	--	--	18.4	1.56	0.81
5	1025	9.95	NC8-26A	5	+2.746	0.76	1.19	11.2	32.0	3.53	1.35
			NC8-334	5	-5.458	1.47	1.18	6.87	22.9	--	1.08
	1000	13.95	65-22-6	7	+3.395	--	--	--	27.2	--	0.94
	1050	17.45	66-4-2	7	+1.560	1.24	2.13	16.0	42.1	6.52	1.60
	1025	9.95	66-9-18	5	+3.352	0.88	5.00	11.3	37.0	3.35	3.52
			66-9-214	5	-8.012	2.18	2.02	5.77	22.1	1.18	1.02
			66-10-19		-2.110	1.43	5.11	12.1	19.6	5.34	1.45
			66-10-216		-1.697	1.51	5.06	12.2	20.1	5.62	1.08
			66-12-6		+3.812	--	--	11.3	36.2	3.63	3.04
			66-12-214		-6.561	1.61	1.14	6.62	38.2	1.43	1.24
7	1025	18.32	65-42-9	7	+8.154	1.86	1.93	14.5	45.5	7.04	1.72
			65-42-202	7	+6.910	1.76	1.95	--	45.8	6.91	1.87
	1000	4.02	AC-2	0	-2.527	--	--	--	--	--	3.45
			AC-6		-2.734	--	--	--	--	--	3.77
			BX-5		-1.951	--	--	--	--	--	3.13
			BX-6		-2.341	--	--	--	--	--	1.57
			BX-202		-2.192	--	--	--	--	--	2.31

TABLE VIII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, ΔL/L ₀ , %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
7 (contd)	1000	4.02	BK-204	0	-2.346		--		--		0.60
			3H-3		-2.535		--		--		3.67
			3H-6		-2.549		--		--		2.93
			3H-9		-2.321		--		--		3.19
			3H-201		-0.692		--		--		4.40
			3F-1		-3.131		--		--		4.42
			3F-11		-2.637		--		--		4.05
			3F-201		-1.935		--		--		5.05
			3F-203		-2.015		--		--		4.94
			3L-6		-2.841		--		--		3.10
			3L-8		-2.995		--		--		3.26
			3L-201		-3.000		--		--		3.14
			3L-205		-2.833		--		--		2.62
9	1300	17.60	NC8-32A	5	+1.821	0.77	1.78	10.9	26.6	3.32	1.99
			NC8-344	5	-6.606	1.52	1.37	6.57	18.6	--	0.98
	1250	10.62	233-26	5	+0.503	0.73	2.70	13.1	29.7	3.55	3.04
	1300	17.60	233-65A	5	+2.587	0.75	2.38	12.7	34.0	--	2.85
	1250	10.62	233-210	5	-6.922	1.68	1.79	7.38	17.2	1.69	1.43
	1300	17.60	233-262	5	-8.405	1.59	3.27	7.83	22.1	--	1.27
	1300	11.81	66-4-9	3	-1.685		2.34	15.6	24.5	6.77	1.96
			66-4-205	3	-1.362		1.22	16.0	25.0	6.76	2.96
			66-9-35		+7.863		2.80		13.0		2.98
			66-9-224		-10.355		--		--		--
			67-4-3		+5.928		1.79		30.6	7.19	2.07
			67-4-208		+2.705		1.84		24.7		1.98
			67-8-5		+2.452		--		18.4		1.10
			67-8-208		-0.338		3.69		15.0	6.49	1.01
			68-1A-4		+0.688		--		24.6		1.142
			68-1A-205		-3.793		1.44		23.9		1.45
			68-2A-4		+1.458		1.24		33.9		1.63
			68-2A-206		-2.882		1.62		31.1		1.00
	10	1325	18.77	NC8-33A	5	+1.342	0.88	1.57	9.92	27.7	--
			NC8-364	5	-7.272	1.46	1.20	6.27	18.3	1.51	0.77
			65-18-121	5	+2.393	1.30	1.86	14.5	24.0	6.58	1.72
1350		17.39	65-21-18	4	-1.240		3.30	8.71	19.4	4.20	1.25
1325		13.24	65-21-225	3	-4.499		3.07		16.2		1.28
		19.25	65-22-17	5	-1.353	1.40	2.10	9.77	17.6	5.16	1.11
			65-22-213	5	-2.724	1.36	3.50	9.62	18.3	4.88	0.94
1325		10.91	65-22-224	3	-3.058		3.37		17.8		1.02
1350		11.11	65-37-9	3	-1.676		1.78		25.6	2.48	1.95
1300		17.87	66-4-4	5	-2.771	1.25	1.55	17.1	25.6	6.60	2.67

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TABLE VIII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C ^(a)	
						Initial	Final	Initial	Final	Initial	Final
10 (contd)	1325	10.91	66-4-10	3	-1.633	---	1.75	16.5	24.3	6.54	4.57
	1350	17.39	66-14-9	4	-0.257	---	---	---	---	2.64	2.23
			66-14-203	4	-2.526	---	1.58	8.41	23.2	2.42	2.11
	1300	16.27	66-15-1	4	-0.408	---	1.21	25.3	35.3	5.22	1.73
	1350	17.39	66-15-4	4	-0.368	---	1.39	---	35.4	5.22	1.48
	1300	16.27	66-15-201	4	-0.103	---	---	---	34.1	5.27	1.88
	1350	17.39	66-15-203	4	+0.643	---	1.98	22.8	35.9	5.93	1.31
			67-3-5	4	-0.743	---	2.39	---	---	4.46	1.37
11	1325	17.36	NC8-47A	4	+0.557	---	1.95	10.1	29.1	3.03	2.69
			NC8-366	4	-7.342	---	0.70	6.84	30.6	1.31	1.39
		19.22	233-248	5	-7.897	1.64	1.44	8.18	22.8	1.78	1.30
		17.36	66-14-2	4	-2.359	---	1.72	9.31	23.6	2.47	2.04
			66-14-209	4	-0.052	---	---	---	---	---	---
			66-15-5	4	-0.892	---	1.09	24.1	36.2	5.45	2.20
			66-15-207	4	+0.094	---	1.83	23.1	36.1	5.96	1.67
	1350	17.41	67-3-204	4	-4.718	---	---	8.74	20.2	3.85	1.06
	1325	17.36	67-4-2	4	+1.555	---	2.08	16.0	27.4	7.20	1.90
			67-4-205	4	+1.924	---	2.21	15.9	26.7	7.24	2.36
			67-5-1	4	+0.191	---	3.47	9.59	16.4	6.73	1.58
			67-5-202	4	-0.835	---	3.83	8.95	16.1	6.78	1.57
			67-8-2	4	+0.718	---	3.74	9.14	18.1	6.59	1.21
			67-8-205	4	-0.919	---	4.40	9.51	17.6	6.69	1.11
	1350	13.33	68-1A-6	3	-1.226	---	1.67	---	24.7	---	2.78
			68-1A-207	3	-3.931	---	2.54	---	27.6	---	1.75
			68-2A-5	3	-0.923	---	2.15	---	31.3	---	1.57
			68-2A-208	3	-3.986	---	1.65	---	27.4	---	2.04
12	1425	7.77	NC8-48A	1	-1.660	---	1.61	---	22.5	---	2.89
			NC8-336	1	-4.565	---	1.37	---	14.4	---	1.46
		8.25	233-85	2	-2.190	---	1.59	---	21.3	---	3.18
			233-309	---	-6.343	---	1.31	---	14.7	---	1.68
			65-21-35	---	-2.813	1.13	1.55	---	15.1	---	3.28
			65-21-226	---	-3.957	1.42	1.54	---	15.2	---	3.01
			65-22-41	---	-3.127	---	2.04	---	15.0	---	3.78
			65-22-225	---	-3.660	1.31	2.06	---	16.3	---	3.25
			65-42-18	---	-0.982	---	1.04	---	---	---	3.35
			66-4-16	---	-3.030	---	1.34	---	20.9	---	4.70
			66-4-209	---	-2.576	---	1.18	---	---	---	4.53
			66-10-20	---	-3.898	---	3.61	---	15.6	---	1.78
			66-14-1	---	-3.451	---	1.63	---	19.5	---	2.63

TABLE VIII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
13	1300	18.58	NC8-43A	5	+2.315	0.84	1.90	10.4	30.2	—	2.81
		16.72	NC8-52A	4	+2.989	—	1.74	9.94	30.3	3.08	2.20
			NC8-365	4	-7.699	—	1.55	5.78	21.3	1.14	1.12
	1325	4.36	AC-7	0	-3.458	—	—	—	—	—	3.82
			BX-7		-2.681	—	—	—	—	—	2.03
			BX-8		-2.675	—	—	—	—	—	2.01
			BX-205		-2.516	—	—	—	—	—	1.98
			BX-207		-2.877	—	—	—	—	—	2.11
			3H-11		-3.300	—	—	—	—	—	3.43
			3H-12		-3.140	—	—	—	—	—	3.74
			3H-206		-0.911	—	—	—	—	—	3.93
			3H-208		—	—	—	—	—	—	3.91
			3F-10		-4.051	—	—	—	—	—	4.27
			3F-205		-1.265	—	—	—	—	—	4.78
			3F-208		-1.469	—	—	—	—	—	4.78
			3L-11		-4.228	—	—	—	—	—	3.46
			3L-12		-4.249	—	—	—	—	—	3.11
			3L-206		-4.162	—	—	—	—	—	3.12
			3L-207		-4.154	—	—	—	—	—	2.72
14	1200	11.54	NC8-273	3	-7.118	—	1.17	—	21.7	—	1.26
	1250	16.43	233-49A	4	+0.127	—	2.14	11.4	27.8	3.19	2.62
			233-266	4	-8.084	—	1.59	7.28	23.2	1.07	1.38
	1200	11.54	233-295	3	-7.872	—	1.24	—	21.3	—	1.42
			234-118	3	+7.071	—	2.13	—	31.5	—	3.61
			234-342	3	-11.868	—	0.89	—	—	—	1.28
		14.29	65-21-19	3	+1.973	—	1.94	8.97	24.2	4.19	0.90
	1275	18.38	65-21-28	5	-1.312	1.11	2.02	9.89	18.8	—	1.33
			65-21-222	5	-4.038	1.46	1.97	8.93	20.1	—	0.79
	1200	14.29	65-21-232	4	-3.675	—	1.40	7.86	22.7	3.44	1.03
	1275	16.52	65-22-13	4	-1.078	—	1.75	8.69	19.9	4.90	0.87
	1250	16.43	65-22-35	4	-2.031	—	2.41	8.34	15.2	4.69	1.04
			65-22-218	4	-3.283	—	1.73	8.62	16.2	4.82	0.81
			65-42-14	4	+0.972	—	—	—	—	6.70	1.88
			65-42-218	4	+0.777	—	4.00	14.7	24.0	5.82	1.92
	1200	11.54	66-4-22	3	-1.618	—	1.71	—	28.0	—	2.52
			67-1-8	3	+4.033	—	2.29	—	21.9	—	1.60
	1250	16.43	67-5-2	4	+0.130	—	3.99	9.53	16.1	7.05	1.58
			67-5-205	4	-0.779	—	3.77	9.12	15.7	6.67	1.22
15	1075	11.90	NC8-28A	5	+10.268	0.81	1.97	11.0	14.3	—	3.68
	1100	12.73	234-144	5	+13.096	0.76	2.81	12.4	16.0	3.66	4.50
	1175	14.70	234-216	5	-13.940	1.83	0.52	5.74	49.3	1.10	2.35

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TABLE VIII. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
15 (cont'd)	1100	12.73	234-296	5	-12.825	1.78	0.66	5.92	34.3	0.99	1.55
	1175	14.70	65-21-27	5	+1.543	--	2.28	9.87	26.8	--	1.40
	1125	13.33	65-22-8	5	+0.569	--	1.82	--	--	--	1.30
		12.07	65-22-29	4	+0.138	--	2.06	8.38	6.10	5.21	0.91
			65-22-210	4	-2.170	--	1.78	8.74	22.6	4.32	1.10
	1075	11.90	65-42-16	5	+2.150	0.98	0.95	--	--	8.04	1.59
			65-42-212	5	+1.732	--	3.44	16.3	26.1	6.89	1.81
	1100	10.83	66-4-18	4	-1.639	--	2.28	14.2	26.2	6.14	1.71
	1075	11.90	66-9-44	5	+16.441	1.27	3.08	11.0	22.7	--	4.83
			66-9-215	5	-9.430	2.24	1.03	5.62	13.3	1.19	1.35
	1175	13.26	66-14-11	4	+2.135	--	1.63	9.17	9.40	2.31	2.54
			66-14-211	4	-1.381	--	1.36	8.40	31.9	1.98	2.33
	1075	15.54	66-15-3	6	+2.255	0.85	1.33	25.3	45.4	5.34	2.16
			66-15-205	6	+3.462	0.85	1.65	24.2	43.8	6.10	1.09
			67-1-10	6	+8.956	1.36	2.31	11.7	32.4	5.30	1.44
			67-1-206	6	+2.918	1.42	1.55	10.5	32.0	4.78	1.23
16	1150	12.87	NC8-363	5	-6.268	1.64	0.78	6.57	19.0	--	3.21
	1125	11.42	65-21-16	4	+0.630	--	2.89	8.88	6.75	4.47	1.46
			65-21-212	4	-3.188	--	3.20	7.80	25.1	3.40	1.32
			65-21-229	4	-2.878	--	2.00	7.51	26.3	3.83	1.28
	925	9.03	65-22-201	7	-2.659	3.07	--	--	21.3	--	2.14
	1125	11.42	65-22-216	4	-1.894	--	0.90	--	--	4.59	1.00
	1075	13.11	66-10-24	5	+0.740	1.43	3.59	11.2	28.4	5.17	1.10
	1150	12.87	66-10-43	5	+0.308	1.45	3.60	11.5	7.85	5.30	1.07
	1075	13.11	66-10-226	5	+1.095	--	4.05	--	7.78	5.71	1.07
	1075	13.11	66-14-4	5	+2.797	--	1.76	--	37.7	--	1.91
			66-14-204	5	-0.052	1.24	1.66	8.85	36.7	2.26	3.04
			66-15-6	4	+0.453	--	1.25	24.6	41.0	5.48	1.02
	1100	11.40	66-15-206	4	+1.053	--	1.26	22.1	38.6	5.75	1.11
			67-3-3	4	+1.812	--	3.15	--	7.92	4.84	1.72
			67-3-201	4	-3.782	--	1.44	8.49	7.58	3.88	1.44
	1125	11.42	67-5-3	4	+1.966	--	4.15	9.80	22.4	7.14	1.29
			67-5-208	4	+1.411	--	4.69	9.30	23.7	6.77	1.13

TABLE IX. GEH-13-422 Experimental Results

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
3	775	5.46	NC8-23A	6	-0.525	0.78	1.29	11.4	35.4	3.42	2.94
		5.02	NC8-356	5	-1.647		2.24	6.27	22.4	1.14	1.09
		5.46	63-16-21	6	-0.175	1.75	1.84	15.9	27.3	6.43	4.05
			63-16-219	6	-0.429	1.82	1.88	15.2	26.6	6.20	4.43
			66-9-13	6	-0.621	0.89	1.27	12.3	33.0	3.51	3.09
			66-9-213	6	-2.419	2.22	1.62	5.82	18.1	1.25	0.84
	800		66-12-204	6	-1.822	1.70	2.13	5.80	19.3	1.29	0.67
		4.35	66-15-7	4	-0.940		1.16	24.9	34.4	5.57	1.57
			68-1A-1	4	-0.543		1.40	--	29.8	--	4.83
			68-1A-202	4	-1.114		1.22	--	34.6	--	4.27
4	925	8.80	NC8-358	6	-4.844	1.68	1.85	--	23.9	1.32	1.45
			234-304	6	-6.842	1.81	1.66	6.02	22.1	0.95	0.93
	925	8.16	63-16-42	5	-0.721	--	3.10	13.5	24.7	6.30	2.02
			63-16-238	5	-1.314	--	3.19	13.4	24.8	5.70	2.11
			65-18-109	5	+1.323	--	2.38	13.3	27.9	6.23	2.45
	925	8.80	65-18-298	6	-1.938	1.43	1.65	13.7	26.5	--	2.38
	950	14.55	65-42-2	8	+3.417	1.99	3.14	--	29.9	6.93	2.23
			65-42-200	8	+2.664	1.74	2.72	16.6	32.7	6.78	2.00
			66-4-1	8	-0.761	1.22	2.29	16.3	34.4	6.48	1.78
			66-4-201	8	-0.026	1.13	1.91	16.6	33.3	6.86	2.20
	925	8.80	66-9-17	6	+1.375	0.89	1.74	11.6	36.3	4.21	3.08
			66-9-212	6	-6.158	--	2.43	--	20.8	1.25	1.11
			66-12-5	6	+2.694	0.92	1.72	11.3	41.1	3.69	3.70
			66-12-203	6	-5.503	--	1.15	--	23.4	1.56	1.42
5	1050	11.76	NC8-26A	6	+5.362	0.76	1.94	11.2	39.8	3.53	3.13
			NC8-334	6	-6.426	1.47	1.32	6.78	27.0	--	1.14
	1025	16.16	65-22-6	8	+4.403	--	3.46	--	29.3	--	1.36
	1050	19.66	66-4-2	8	+2.575	1.24	1.49	16.0	44.2	6.52	1.18
	1050	11.76	66-9-18	6	+7.093	0.88	1.82	11.3	47.7	3.35	3.52
			66-9-214	6	-8.502	2.18	0.89	5.77	29.3	1.18	1.50
			66-10-19	6	-1.780	1.43	1.71	12.1	20.2	5.34	1.25
			66-10-216	6	-1.293	1.51	1.91	12.2	20.8	5.62	1.13
			66-12-6	6	+7.465	0.91	3.24	11.3	46.5	3.63	3.85
			66-12-214	6	-6.403	1.61	1.04	--	--	1.43	1.75
7	1050	21.14	65-42-9	8	+10.275	1.86	1.79	14.5	48.1	7.04	1.92
			65-42-202	8	+8.688	1.76	1.86	--	46.6	6.91	1.85
	1100	6.84	AC-2	0	-3.310						3.48
			AC-6	1	-3.354						3.10

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TABLE IX. (Con'd)

Capsule Position	Temp., °C	Fluence, $nvt \times 10^{21}$ ($E > 0.18 \text{ MeV}$)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0, \%$	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi $\times 10^{-6}$		ohm-cm $\times 10^4$		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
7 (Con'd)	1100	6.84	BX-5	0	-2.372						1.50
			BX-6		-2.423						2.32
			BX-202		-2.552						2.22
			BX-204		-2.336						1.81
			3H-3		-2.975						2.77
			3H-6		-3.059						2.92
			3H-9		-3.057						3.41
			3H-201		+0.114						1.78
			3F-1		-3.971						4.31
			3F-11		-3.988						4.96
			3F-201		-1.724						4.73
			3F-203		-1.669						5.06
			3L-6		-4.076						2.69
			3L-8		-4.242						2.36
			3L-201		-3.977						2.69
			3L-205		-4.021						2.82
9	1300	20.64	NC8-32A	6	+3.272	0.77	1.55	10.9	23.5	3.32	2.22
			NC8-344	6	-7.264	1.52	1.29	6.57	24.5	--	1.32
	1275	13.66	233-26	5	+1.988	0.73	0.77	13.1	26.0	3.55	2.94
	1300	20.64	233-65A	6	+4.071	0.75	2.14	12.7	29.4	--	2.73
	1275	13.66	233-210	5	-7.910	1.68	1.58	7.38	16.0	1.69	1.62
	1300	20.64	233-262	6	-9.099	1.59	1.17	7.83	20.4	--	1.76
	1300	15.52	234-347	4	-10.327	--	1.64		15.8	0.85	0.92
	1300	14.97	66-4-9	4	-1.670		1.96	15.6	23.4	6.77	1.89
			66-4-205	4	-1.717		1.46	16.0	21.4	6.76	2.31
			66-9-35	4	+10.271		2.32		46.7		2.73
			66-9-224	4	-10.706		0.61		31.1		1.71
			67-4-3	4	+7.547		1.74		31.3	7.19	1.92
			67-4-208	4	+3.351		1.64		26.2		2.25
			67-8-5		+3.161		1.10		18.4		1.37
			67-8-208		-0.266		1.75		14.6	6.49	1.19
			68-1A-4		+1.083		1.53		24.2		1.08
			68-1A-205		-3.861		1.66		22.9		1.17
			68-2A-4		+2.069		1.03		33.0		1.44
			68-2A-206		-2.739		1.39		27.2		0.84

TABLE IX. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, ΔL/L ₀ , %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion		
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)		
						Initial	Final	Initial	Final	Initial	Final	
10	1325	22.00	NC8-33A	6	+2.643	0.88	2.19	9.92	24.5	--	2.98	
			NC8-364	6	-7.947	1.46	1.31	6.27	18.2	1.51	1.45	
			65-18-121	6	+3.705	1.30	1.72	14.5	21.1	6.58	1.66	
	1350	20.62	65-21-18	5	-0.945	--	1.76	8.71	22.1	4.20	1.41	
	1325	16.47	65-21-225	4	-4.601	--	3.24	--	14.0	--	1.17	
		22.48	65-22-17	6	-1.155	1.40	3.58	9.77	15.1	5.16	0.98	
			65-22-213	6	-2.750	1.36	3.77	9.62	17.2	4.88	1.07	
	1325	14.14	65-22-224	4	-3.150	--	3.19	--	15.6	--	1.14	
	1350	14.34	65-37-9	4	-1.033	--	0.99	--	26.4	2.48	2.03	
	1300	21.10	66-4-4	6	-3.104	1.25	1.71	17.1	23.3	6.60	2.76	
	1325	14.14	66-4-10	4	-2.318	--	1.44	16.5	21.9	6.54	3.95	
	1350	20.62	66-14-9	5	+0.071	--	1.45	9.05	21.6	2.64	1.96	
			66-14-203	5	-2.282	--	1.43	8.41	21.2	2.42	2.36	
	1300	19.50	66-15-1	5	-0.396	--	1.33	25.3	30.5	5.22	1.71	
	1350	20.62	66-15-4	5	-0.359	--	1.48	--	33.2	5.22	1.29	
	1300	19.50	66-15-201	5	-0.090	--	1.42	--	32.4	5.27	1.69	
	1350	20.62	66-15-203	5	+0.891	--	1.75	22.8	31.8	5.93	1.40	
			67-3-5	5	-0.259	--	0.45	--	--	4.46	1.27	
	11	1325	20.60	NC8-47A	5	+1.809	--	1.60	10.1	26.4	3.03	2.79
		1325		NC8-366	5	-7.890	--	1.08	6.84	32.9	1.31	1.25
1325		22.46	233-248	6	-8.505	1.64	1.23	8.18	20.4	1.78	1.39	
1225		14.72	66-10-23	4	+0.759	1.37	--	11.9	20.4	5.82	1.14	
			66-10-229	4	+0.648	--	--	12.1	20.3	--	0.98	
1325		20.60	66-14-2	5	-2.187	--	1.47	9.31	20.1	2.47	2.44	
			66-15-5	5	-0.940	--	1.16	24.1	34.4	5.45	1.57	
			66-15-207	5	+0.194	--	1.68	23.1	33.1	5.96	1.60	
1350		20.65	67-3-204	5	-4.630	--	--	8.74	15.7	3.85	1.26	
1325		20.60	67-4-2	5	+2.531	--	1.46	16.0	28.4	7.20	2.21	
			67-4-205	5	+2.534	--	1.68	15.9	26.9	7.24	2.21	
			67-5-1	5	+0.202	--	3.71	9.59	14.4	6.73	1.44	
			67-5-202	5	-0.789	--	3.87	8.95	13.5	6.78	1.36	
			67-8-2	5	+1.115	--	--	9.14	17.3	6.59	1.14	
			67-8-205	5	-0.759	--	3.85	9.51	15.0	6.69	1.30	
1350		16.57	68-1A-6	4	-0.917	--	1.94	--	18.7	--	2.06	
			68-1A-207	4	-3.889	--	1.66	--	21.4	--	1.57	
			68-2A-5	4	-0.401	--	1.53	--	22.8	--	1.96	
			68-2A-208	4	-4.085	--	--	--	21.3	--	1.34	

TABLE IX. (Con'd)

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Capsule Position	Temp., °C	Fluence, nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
12	1425	10.95	NC8-48A	2	-1.174		1.68		13.0		2.67
			NC8-336	2	-5.826		1.59		13.0		1.03
		11.43	233-85	3	-1.231		1.61		20.0		3.39
			233-309	3	-7.397		1.63		13.9		1.81
		6.89	234-76	3	-1.865		--		27.7		3.82
		11.43	65-21-35	3	-2.789	1.13	2.34		12.7		2.43
			65-21-226	3	-4.550	1.42	2.04		12.9		2.26
			65-22-41	3	-0.151		2.41		12.6		2.74
			65-22-225	3	-4.033	1.31	1.39		14.5		2.86
			65-42-18	3	-1.059		1.89		--		3.15
			66-4-16	3	-3.778		1.20		21.0		3.78
			66-4-209	3	-3.112		1.28		21.1		4.31
			66-10-20	3	-3.704		3.83		13.5		1.64
			66-14-1	3	-3.540		1.61		15.7		2.50
13	1300	21.64	NC8-43A	6	+4.145	0.84	2.16	10.4	33.6		2.86
		19.78	NC8-52A	5	+5.257	--	1.90	9.94	37.3	3.08	3.19
			NC8-365	5	-7.939		1.27	5.78	23.5	1.14	1.58
	1350	7.42	AC-7	1	-3.347						3.94
			BX-7		-0.380						2.04
			BX-8		-0.753						2.04
			BX-205		-0.288						2.51
			BX-207		-1.690						2.11
			3H-7		-2.896						3.26
			3H-11		-2.855						2.46
			3H-12		-2.950						3.37
			3H-206		+0.203						4.27
			3H-208		+0.870						3.70
			3F-10		-3.480						4.00
			3F-205		-0.092						3.78
			3F-208		+0.027						4.38
			3L-11		-4.412						2.09
			3L-12		-4.431						2.25
			3L-206		-4.243						2.28
			3L-207		-4.104						
14	1225	14.40	NC8-273	4	-7.539		1.11		23.2		1.62
	1250	19.29	233-49A	5	+1.599		4.46	11.4	27.0	3.19	2.19
			233-266	5	-8.264		1.27	7.28	27.3	1.07	1.65
	1225	14.40	233-295	4	-8.168		0.99		25.2		1.90
			234-118	4	+9.643		2.83		36.8		4.96

TABLE IX. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus psi x 10 ⁻⁶		Electrical Resistivity ohm-cm x 10 ⁴		Coeff. of Thermal Expansion 10 ⁻⁶ per °C (a)	
						Initial	Final	Initial	Final	Initial	Final
14 (Con'd)	1225	14.40	234-342	4	-12.502		0.70		26.0		1.61
	1200	17.15	65-21-19	5	+2.082		2.07		27.0	4.19	1.65
	1275	21.24	65-21-28	6	-0.834	1.11	1.82	8.97	18.3		1.31
			65-21-222	6	-3.774	1.46	3.01	9.89	20.9		1.21
	1200	17.15	65-21-232	5	-3.071		2.42	8.93	24.0	3.44	0.99
	1275	19.38	65-22-13	5	-0.507		4.08	7.86	18.6	4.90	0.94
	1250	19.29	65-22-35	5	-1.738		4.52	8.69	16.9	4.69	0.95
			65-22-218	5	-2.796		3.68	9.34	16.5	4.82	1.16
			65-42-14	5	+1.700		0.94	8.62	24.7	6.70	1.02
			65-42-218	5	+1.345		2.21		25.3	5.82	2.36
	1225	14.40	66-4-22	4	-1.886		1.53	14.7	27.4		2.92
			67-1-8	4	+5.060		3.02		22.8		1.49
	1250	19.29	67-5-2	5	+0.460		4.31	9.53	16.0	7.05	1.38
			67-5-205	5	-0.728		4.52	9.12	14.5	6.67	1.19
15	1175	17.24	234-216	6	-14.448			5.74	77.2	1.10	2.87
	1125	15.27	234-296	6	-13.163	1.78	0.72	5.92	48.3	0.99	2.29
	1175	17.24	65-21-27	6	+3.336		2.02	9.87	30.7		1.93
	1125	13.94	65-21-16	5	+1.612		2.34	8.88	31.9	4.47	1.99
			65-21-212	5	-2.796		1.72	7.80	27.3	3.40	1.19
			65-21-229	5	-2.222		2.09	7.51	30.0	3.83	1.71
	1125	15.87	65-22-8	6	+2.074		2.69	9.67	29.1		1.26
		14.61	65-22-29	5	+0.808		2.58	8.38	23.4	5.21	2.07
			65-22-210	5	-1.452			8.74	24.1	4.32	1.43
	1100	14.44	65-42-16	6	+3.201	0.98	1.07		26.9	8.04	1.71
			65-42-212	6	+2.681		1.69	16.3	31.2	6.89	2.40
		13.37	66-4-18	5	-1.490		2.52	14.2	27.6	6.14	2.02
	1100	14.44	66-9-215	6	-9.007	2.24	0.46	5.62	71.4	1.19	3.15
	1175	15.80	66-14-11	5	+4.170		1.89	9.17	37.6	2.31	3.96
			66-14-211	5	+0.250		1.41	8.40	37.7	1.98	3.22
	1100	18.08	66-15-3	7	+2.416	0.85	1.85	25.3	49.4	5.34	1.35
			66-15-205	7	+3.079	0.85	1.86	24.2	48.8	6.10	1.39
			67-1-10	7	+10.124	1.36	2.80	11.7	34.2	5.30	1.37
			67-1-206	7	+3.899	1.42	2.67	10.5	33.4	4.78	1.34

TABLE IX. (Con'd)

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Capsule Position	Temp., °C	Fluence, ²¹ nvt x 10 ²¹ (E > 0.18 MeV)	Sample Number	No. of Previous Irradiations	Length Change, $\Delta L/L_0$, %	Young's Modulus		Electrical Resistivity		Coeff. of Thermal Expansion	
						psi x 10 ⁻⁶		ohm-cm x 10 ⁴		10 ⁻⁶ per °C(a)	
						Initial	Final	Initial	Final	Initial	Final
16	1125	14.94	NC8-363	6	-5.137			6.57	93.0		1.42
	950	11.10	65-22-201	8	-3.162		2.60		22.2		1.75
	1125	13.49	65-22-216	5	-1.392					4.59	1.44
	1075	15.18	66-10-24	6	+1.434	1.43	2.97	11.2	31.6	5.17	1.32
	1125	14.94	66-10-43	6	+1.379	1.45	2.78	11.5	30.8	5.30	1.24
	1075	15.18	66-10-226	6	+2.023		3.17		31.4	5.71	1.12
			66-14-4	6	+5.291		2.42		4.84		4.10
			66-14-204	6	+1.933			8.85	49.9	2.26	4.07
	1125	13.47	66-15-6	5	+1.313		1.48	24.6	51.6	5.48	1.83
			66-15-206	5	+1.558		1.43	22.1	47.4	5.75	1.96
			67-3-3	5	+3.205		1.14		33.8	4.84	1.89
			67-3-201	5	-3.226		1.42	8.49	27.9	3.88	1.64
	1125	13.49	67-5-3	5	+2.384		4.25	9.80	24.2	7.14	1.85
			67-5-208	5	+1.861		3.48	9.30	26.0	6.77	1.70

TABLE X. GEH-13-451 and GEH-13-452 Experimental Results

Sample No.	GEH-13-451				GEH-13-452			
	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^{-21}$ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	CTE $\times 10^{-6}$ per °C(a)	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^{-21}$ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	CTE $\times 10^{-6}$ per °C(a)
AC-1	550	4.97	-1.62	4.51	550	8.43	-2.581	4.58
AC-4	525	5.50	-1.63	4.49	525	9.66	-2.632	4.44
BX-2	525	5.64	-0.97	5.53	525	9.81	-2.126	5.38
BX-3	500	4.53	-0.66	5.53	525	8.25	-1.449	5.04
BX-203	525	5.63	-0.89	5.67	525	9.83	-2.004	5.09
BX-206	500	4.26	-0.57	5.70	525	7.85	-1.316	5.69
3F-4	550	4.37	-1.43	4.91	550	7.40	-2.533	5.11
3F-6	525	5.59	-1.62	4.44	525	9.80	-3.109	4.97
3F-202	550	4.70	-1.12	5.26	550	7.96	-1.963	5.59
3H-2	500	4.90	-1.35	4.07	525	8.84	-2.502	4.70
3H-4	525	5.54	-1.59	4.41	525	9.57	-2.710	4.74
3H-202	525	5.63	-1.11	5.48	525	9.74	-1.608	5.81
3H-204	500	4.72	-0.90	4.94	525	8.56	-1.178	5.31
3L-1	550	5.25	-1.37	4.06	550	9.03	-2.816	4.79
3L-3	500	5.37	-1.33	4.28	525	9.48	-2.612	4.45
3L-202	500	5.10	-1.26	4.67	525	9.13	-2.499	4.29
3L-203	525	5.43	-1.49	4.19	525	9.35	-2.779	4.58

(a) Mean CTE, 25-425 °C.

TABLE XI. GEH-13-481 and GEH-13-482 Experimental Results

Sample No.	GEH-13-481				GEH-13-482			
	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^{21}$ (E > 0.18 MeV)	Length Change $\Delta L/L_0$, %	CTE $\times 10^{-6}$ per °C (a)	Temp., °C	Fluence, $^{21}\text{nvt} \times 10^{21}$ (E > 0.18 MeV)	Length Change, $\Delta L/L_0$, %	CTE $\times 10^{-6}$ per °C (a)
AC-3	825	4.97	-1.81	4.24	800	8.43	-2.455	4.18
AC-8	750	5.50	-1.88	3.95	775	9.66	-2.860	3.66
BX-1	725	4.53	-0.46	5.01	750	8.25	-1.518	3.60
BX-4	775	5.64	-0.89	3.94	800	9.81	-2.205	2.56
BX-200	775	5.63	-0.72	4.10	825	9.83	-1.900	2.98
BX-201	700	4.26	-0.36	5.24	750	7.85	-1.171	4.27
3F-2	750	5.59	-1.90	4.55	750	9.80	-3.296	4.87
3F-8	850	4.37	-1.74	4.75	800	7.40	-2.841	5.39
3F-206	825	4.70	-1.35	5.22	825	7.96	-1.880	5.59
3H-1	725	4.90	-1.28	3.99	750	8.84	-2.360	4.11
3H-5	800	5.54	-1.69	3.47	800	9.57	-2.594	3.73
3H-203	725	4.72	-0.70	5.16	750	8.56	-0.992	4.92
3H-207	775	5.63	-0.85	4.83	800	9.74	-0.685	4.65
3L-2	825	5.25	-1.48	3.59	800	9.03	-2.874	3.13
3L-4	750	5.37	-1.20	4.31	775	9.48	-2.769	3.45
3L-204	800	3.92	-1.39	3.71	800	9.35	-2.753	3.07
3L-208	725	5.10	-1.12	3.24	750	9.13	-2.637	3.32

(a) Mean CTE, 25-425 °C.

DISCUSSION AND CONCLUSIONS

In previous publications,⁽¹⁻⁵⁾ the radiation-induced changes in physical properties and dimensions have been discussed in detail both in regard to the general trends and in regard to specific types of graphite. The minor changes in irradiation temperatures, which have been introduced in this compilation (see Appendix B), have very little effect on the previous conclusions. The latest data, obtained at higher fluences and to slightly higher temperatures tend to confirm previous conclusions; perhaps the most important information which has been obtained from the latest irradiations are the additional data at very high fluence (to more than 2×10^{22} n/cm²) which show that the post-turnaround expansion rates are much lower at temperatures above about 1200 °C than they are at lower temperatures.

The general conclusions which have been drawn from data obtained during this series of irradiations can be summarized as follows:

- Dimensional changes of graphites prepared from conventional - and needle-shaped petroleum cokes follow one general pattern at irradiation temperatures above 300 °C: Samples first contract, then go through a minimum ("turnaround") and then expand.
- At temperatures between about 300 and 800 °C,⁽¹⁾ the contraction rate decreases as the temperature increases and turnaround is reached at about the same fluence for all irradiation temperatures.
- At temperatures in the range from about 800 to 1200 °C,^(1,5) normal petroleum coke graphites reach turnaround at lower fluences and then expand very rapidly. Within this temperature range, samples at the higher temperatures turnaround at the lowest fluences and expand the most rapidly.

- Another critical temperature region exists at about 1200 °C: ⁽⁴⁾ at higher temperatures, the initial contraction rates of the transverse samples are reduced, turnaround is delayed to higher fluences for both the parallel and transverse samples and expansion rates are lower after turnaround than they are below 1200 °C.
- Although there are differences in the radiation-induced changes in physical properties among the various graphites, the general trends ^(1,2) are an initial decrease in coefficient of thermal expansion until after turnaround. Both electrical resistivity and Young's modulus show an initial increase, with the electrical resistivity quickly reaching a quasi-saturation level at low fluence. After turnaround, as voids begin to open up within the sample, electrical resistivity again increases rapidly and the strength decreases rapidly.
- The more isotropic graphites, made from raw cokes, Gilsonite cokes, or other proprietary filler materials, ⁽³⁾ generally show less dimensional change than do the normal petroleum coke materials. Although the changes in electrical resistivity and Young's modulus tend to show the same general behavior for the isotropic materials as for the normal petroleum coke materials, the changes in coefficient of thermal expansion are evidently more dependent on filler material.

For specific information in regard to individual graphites, the reader is referred to previous publications, ⁽¹⁻⁵⁾ or to the actual data tabulated in this report.

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APPENDIX A

SAMPLE SELECTION AND SUFFIX NUMBERS

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SAMPLE SELECTION AND SUFFIX NUMBERS

Figures A1 through A6 show typical sampling schemes for the materials listed in Table 1. Samples are identified, in Tables III through XI, by sample prefix (NC8-, 233-, 63-16-, etc.) and a sample suffix number (-1, -203, etc.). Normally, numbers 1-199 are assigned to transverse samples and numbers 200-399 are assigned to parallel samples; specific exceptions to the normal sampling numbering sequence are shown in Figures A1 through A6.

FIGURE A2. Sampling Scheme - Cylindrical Extrusion

	SAMPLE ORIENTATION	
	⊥	
NORMAL SAMPLE SUFFIX NUMBERS:	1-199	200-399
ABNORMAL SAMPLE NUMBERS:		
63-19	200-399	1-199
64-17	200-399	1-199

FIGURE A4. Sampling Scheme - Rectangular Molding

FIGURE A5. Sampling Scheme - Isostatically Molded Block

FIGURE A6. Sampling Scheme - Isostatically Molded Cylinder

APPENDIX B

TEMPERATURE CORRECTIONS

APPENDIX B

TEMPERATURE CORRECTIONS

Several factors can affect the emf output of a thermocouple during irradiation; transmutation of elements, especially by thermal neutrons, will change the composition of the thermocouple wires. This change in composition is important only to the extent that it alters the emf versus temperature response of the thermocouple. The emf of some combinations of thermocouple materials, such as chromel/alumel,⁽⁷⁾ seem to be relatively unaffected by neutron irradiation; the emf of other combinations of thermocouple materials can change significantly⁽⁸⁾ after only a short irradiation, or even during testing at elevated temperatures.

In an operating irradiation capsule, the practical problem of thermocouple emf changes is further complicated by the fact that local temperature gradients may exist due to thermal contact between the thermocouple wires and internal parts of the capsule and/or the exterior wall of the capsule. Because these local temperature gradients are superimposed on the general compositional gradients, they will affect the emf output of the thermocouple. Thus, it is not possible to precisely specify thermocouple decalibration factors from a knowledge of the conditions at only thermocouple junction.

In spite of these practical problems, it is important, in an experimental irradiation program of this type, to attempt to specify irradiation temperatures as precisely and as accurately as possible. Helm⁽⁹⁾ has reported the results of post-irradiation calibrations of Geminol (N,P) thermocouples retrieved from previous irradiation capsules; although it was not possible to specify a thermocouple decalibration factor as a function of neutron fluence, the results indicated that a correction factor

of 1.044 should be applied to the temperatures indicated by Geminol thermocouples after exposure to thermal neutron fluences between about 0.5 and 2.0×10^{21} n/cm². Consequently, the reported temperature has, in the past, been arrived at by multiplying the fluence-averaged temperature, indicated by Geminol thermocouples, by a factor of 1.044. This policy has been adhered to in the present report where Geminol thermocouples were used to monitor sample temperatures.

Geminol thermocouples, however, have a high failure rate during irradiation at the higher temperatures obtained in the GEH-13-1X and -42X series of capsules. Therefore, beginning with GEH-13-13, temperatures of many of the sample holders were monitored by W 5% Re/W 26% Re thermocouples. The W/Re thermocouples exhibited a considerably higher survival rate than did the Geminol thermocouples, but suffered larger changes in emf output during irradiation. In earlier publications⁽²⁻⁴⁾ of data from this series of irradiations different correction factors have been utilized for different capsules, depending on which factor gave the best agreement with the surviving Geminol thermocouples.

In compiling the data for this report, an attempt has been made to apply correction factors in a more consistent manner. The W/Re thermocouple decalibration data, shown in Figure B1, was compiled from three sources:

- In GEH-13-13 a Geminol thermocouple (G-7) and a W/Re thermocouple (W-5) were in the same sample holder and temperatures were monitored during capsule operation. Although most of the changes between the temperatures indicated by G-7 and W-5 occurred gradually, a large change occurred during the reactor shutdown at the end of Cycle 86; it is quite likely that this sudden change was produced by a change in thermal grounding of one or more thermocouple wires at some point in the capsule.

- In GEH-13-14, two W/Re thermocouples (W-3 and W-4) were in sample holders on either side of, and immediately adjacent to, the sample holder monitored by a Geminol thermocouple (G-4). Since the gas-gaps of these three sample holders were the same, relative temperatures were unaffected by variations in gas composition and changes in the ratio: $\text{Temp (G-4)} / 1/2 [\text{Temp. (W-3)} + \text{Temp. (W-4)}]$ should be a direct indication of relative thermocouple calibration changes for the thermocouple materials. Again, although most changes occurred gradually, there appeared to be rapid changes due to variations in thermal grounding of individual wires.
- Two W/Re thermocouple junctions were retrieved from GEH-13-15 and calibrated against a standard thermocouple. Because only a short length of wire could be retrieved and because thermal gradients in the calibration furnace are quite unlike the conditions existing in the operating capsule, some question exists as to the direct applicability of such data, but it falls within the band defined by the other data points.

All data are plotted versus "Adjusted Effective Operating Days," (AEOD) which is defined in the following manner:

$$\text{AEOD} = \left(\frac{\text{MWd}}{175} \right) \frac{\phi_{\text{th}}}{3.86 \times 10^{14}}$$

where

MWd = Accumulated megawatt days of reactor power since insertion of the thermocouple, and

ϕ_{th} = the thermal flux measured, at the position of the thermocouple junction, using the $^{58}\text{Fe} (n, \gamma) ^{59}\text{Fe}$ activation reaction and a thermal neutron cross section of 1.14 barns.

The exact placement of the correction curve within the band of data points is, admittedly, somewhat arbitrary; however, the authors believe that the corrections are not unreasonable and yield corrected temperatures which are in substantial agreement with temperatures indicated by Geminol thermocouples.

Assuming that the corrections for Geminol decalibration are correct, this is equivalent to a change of about -6% per 10^{21} n/cm² (thermal) in the emf output of the W 5% Re/W 26% Re thermocouples. This change is in essential agreement with other W/Re thermocouple data.⁽⁸⁾

In addition to the thermocouple decalibration corrections, three other effects influence operating temperatures; these are:

- a. Variation of γ -heating rates with time.
- b. Variation of heat-transfer coefficients with time.
- c. Changes in thermal conductivity of the sample holders.

During an operating cycle in a test reactor, the gamma-heating rates vary both in absolute intensity and in relative intensity along the length of a capsule position as the isotopic content of the adjacent fuel changes and with adjustments the positioning of control rods. Variations in heat-transfer coefficients across the gas-gap occur, independently of changes in gas composition, due to 1) blackening of the capsule walls, which occurs during the first few days of operation, and 2) variations in width of the gas gap as the diameter of the sample holders change during irradiation.

The changes in gamma-heating rates and in heat transfer coefficients can be partially compensated for in capsule design and partially compensated by changes in the gas-composition during operation; however, in practice, temperatures of the sample holders, especially those at the ends of the capsules, vary with time. During a normal operating cycle, temperatures at sample

positions near the ends of the capsules may vary ± 75 °C from the fluence-averaged temperatures which are reported.

During irradiation, the thermal conductivity of the sample holder decreases thereby increasing the temperature gradient between the thermocouple, near the outer edge of the sample holder, and the sample position within the holder. Calculations have indicated that the temperature at the center of the sample holder for the two-inch diameter (GEH-13-1X) capsules may be as much as 75 °C higher than the temperature at the thermocouple bead for a gamma-heating rate of 15 watts per gram and as much as 120 °C for the sample holders in the 2.5 inch diameter (GEH-13-42X) capsules at the same gamma-heating rate. Since most samples are located away from the center and only a few of the sample holders are at positions where the gamma-heating rate is as high as 15 watts per gram, the actual fluence averaged temperatures of the samples are probably only about 5% higher than the reported fluence-averaged temperatures for the sample holders.

In the GEH-13-45X and -48X capsules, temperatures were monitored with chromel/alumel thermocouples, which seem to be relatively unaffected by neutron irradiation; temperatures reported for these samples are, thus, neutron fluence averaged, but did not require corrections for thermocouple decalibration.

FIGURE B-1. Multiplication Factor for Correction of Irradiated
W 5%Re/W 26%Re Thermocouples

APPENDIX C

NEUTRON FLUENCE DETERMINATIONS

APPENDIX C

NEUTRON FLUENCE DETERMINATIONS

Neutron fluences were determined by analysis of the activities of flux monitor wires either included in the capsules (H-3-2X and GEH-13-1X) or irradiated at positions adjacent to the capsules (GEH-13-42X, -45X, and -48X capsules). In the H-3-2X and GEH-13-1X capsules, wires of nickel and an alloy of cobalt were included along with iron wires; however, primary dependence was placed on the results obtained from activities of the iron wires, the nickel and cobalt activities were used mostly as a secondary check on the results.

In the later capsules, only iron wires were irradiated; activities of ^{54}Mn and ^{59}Fe were determined by direct counting^(10,11) using NaI(Tl) or Ge(Li) detectors.

The method used for calculating effective (neutron spectrum averaged) cross sections has been reported previously.⁽¹²⁾ All neutron fluences reported herein are in terms of neutron with energies greater than 0.18 MeV ($E > 0.18 \text{ MeV}$); the number of atomic displacements per unit fluence has been shown⁽¹³⁾ to have an approximately constant proportionality to fluence ($E > 0.18 \text{ MeV}$). The subject of atomic displacement rates and neutron fluence determinations is being reviewed at the present time.⁽¹⁴⁾

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