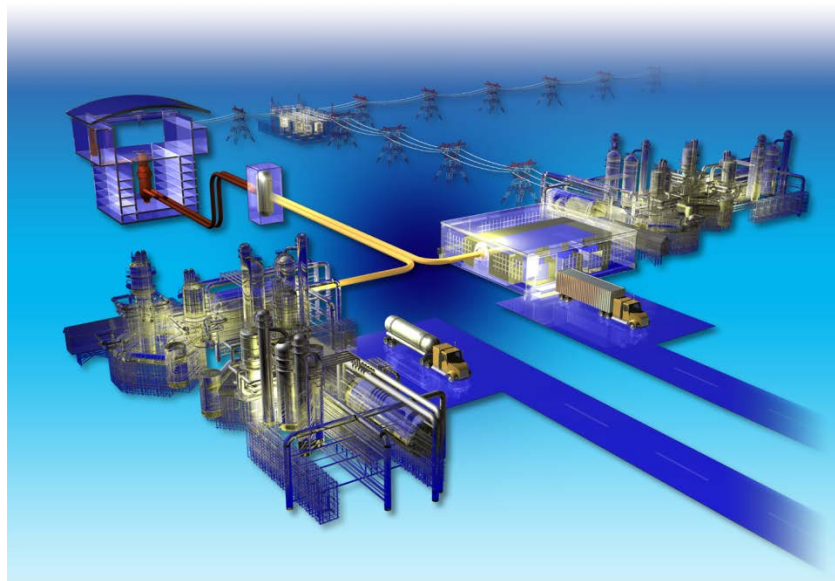


THE RESULTS OF 3-POINT FLEXURE TESTING OF IRRADIATED AGC-1 GRAPHITES SPECIMENS

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March 2015



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SPECIMENS**

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Summary

Here we report the test data from AGC-1 specimen 3-pt flexure testing. At this time all mechanical (flexural) testing of AGC-1 specimens has been completed. Individual force-extension curves are available as .txt files recorded electronically and are available from the author (burchelltd@ornl.gov). Typical curves are included for both the unirradiated and irradiated specimens. The flexure strength has been calculated for each specimen. This letter report meets Idaho National Laboratories statement on Work No. 10752 Rev. 3 deliverable 4.4B “Issue an **electronic letter report** communication indicating the status of AGC-1 mechanical testing to INL no later than March 27, 2015.”

1. Introduction

Initially, glued ends tensile testing of the AGC-1 specimens was planned. However, the results of sister specimen testing¹ showed this technique to be unreliable, with multiple fractures occurring at or around the glued specimen end. Because the glued end technique was shown to be unreliable, Idaho National Laboratory researched an acceptable flexural test method that could be applied to the AGC-1 specimens. Ultimately, this lead to an approved test procedure² which was used to flexure test the AGC-1 specimens. The results of this testing is reported here as a letter report and satisfies SOW No. 10752 Rev. 3 deliverable 4.4B due March 27th 2015. Subsequently we shall report a detailed analysis, including the fractional changes in strength and the variation of flexure strength with irradiation dose to fulfill SOW no.10752 Milestone 4.4C. "Issue a draft TM report summarizing the results and fill analysis of all mechanical testing" no later than May 15, 2015.

2. Experimental

Testing was carried out in accordance with the approved internal procedure (MSTD/FMNS-001²)

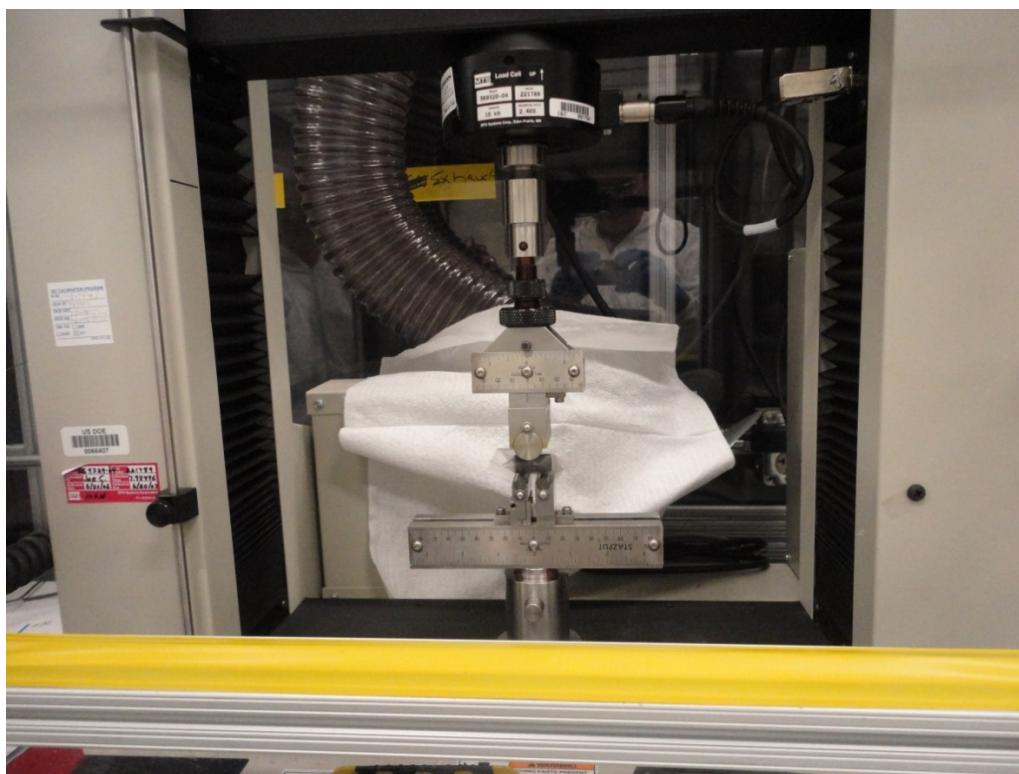


Figure 1 Test frame and load cell for AGC-1 specimen flex testing

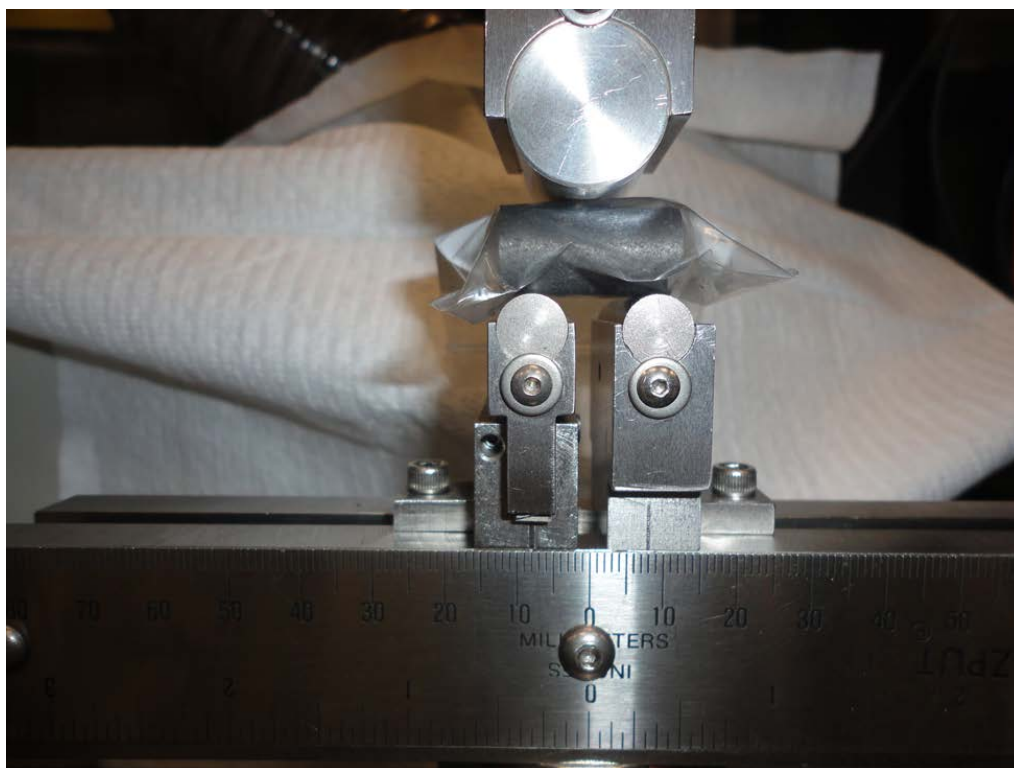


Figure 2 3-pt test fixture for flexure testing AGC Specimens

The specimen set up as in Figure 2, for a circular cross section, the flexural strength is given by:

$$\sigma = (8 P L)/(\pi D^3)$$

Where: D = specimen diameter.

P = break force

L = support span

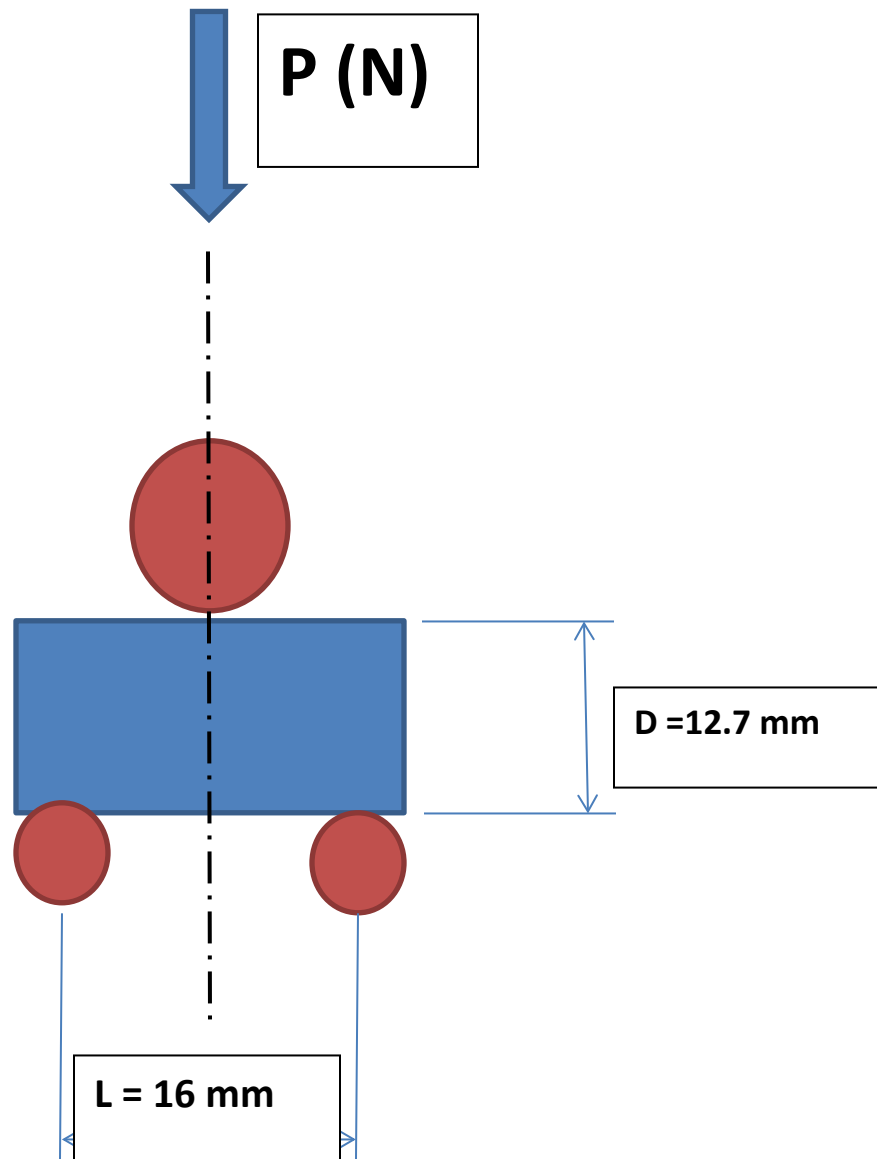


Figure 3 test set-up diagram for 3 pt. flexure defining the parameters P, D and L.

3. Results and Discussion

The number of specimen flexure tested is reported here in Table 1. A total of 265 specimens were tested, consisting of 103 unirradiated and 162 irradiated specimens. The strength data for the specimens are reported here along with typical Load (lbf)-crosshead deflection curves. All the raw data for force and crosshead deflection was recorded digitally and are available upon request from the author (burchelltda@ornl.gov). The reduced data are tabulated below; sections of the tables are highlighted indicating changes in crosshead speed (initially) or where the data are considered unreliable due the fracture location. The load curves were supplied in electronic files .txt files as lb(force) and inches. The fracture load has been converted to MPa in Table 2 to Table 14.

Table 1 the number of 3-pt. flexure test specimens broken and reported here

GRADE LETTER	Grade	WG/AG	Number of specimens tested	
			Unirradiated	Irradiated
A	NBG-17	WG per	16	4
A	NBG-17	AG par	11	26
B	NBG-18	WG per	10	4
B	NBG-18	AG par	14	29
C	H-451	WG (par)	11	17
D	PCEA	WG (par)	8	4
D	PCEA	AG (per)	12	28
E	IG-110	ISO	9	20
F	IG-430	ISO	12	30
TOTALS			103	162

3.1.Unirradiated Specimen Flexure Strength

Prior to testing the irradiated specimens a number of unirradiated specimens were tested to establish a baseline value for each grade. Typical force-extension curve for the graphite grades examined here are shown in Figure 4. Grade IG-430 appears to be considerably stronger the other grades whereas H-451 in

significantly weaker than the other grades. Grades NBG-17, NBG-18, PCEA and IG-110 all fall within the 3-pt bend strength range 40-50 MPa.

The processed data for the all the unirradiated specimens tested are reported in Table 2 through Table 7 and the flexure data are summarized and compared with manufacturer's literature data in Table 8. The measured flexure strengths that we determined (Table 8) for the grades examined here were consistently greater than the manufacturers reported values. As expected the 3 pt values (our data) reflected the usual observation the recoded 3-pt flexure gives a higher strength value the 4-pt flexure due to the increased shear stress in the specimen. Moreover, the specimen's small size and small aspect ratio (length/diameter =2/1) almost certainly contributed to the large apparent strengths of the graphites examined here. Despite the inaccuracy in the reported flexure strength the comparative changes upon irradiation are what we are really interested in, and provide the same technique is used for unirradiated and irradiated specimens the fractional changes observed on irradiation should be accurate. The load and extension data were recorded electronically and saved as text files for every specimen tested. The raw data (text files) are available upon request from the author (burchelltd@ornl.gov).

A full data analysis, i.e., the effect of irradiation and irradiation induced creep strain on the flexure strength shall follow in an ORNL/TM later this year.

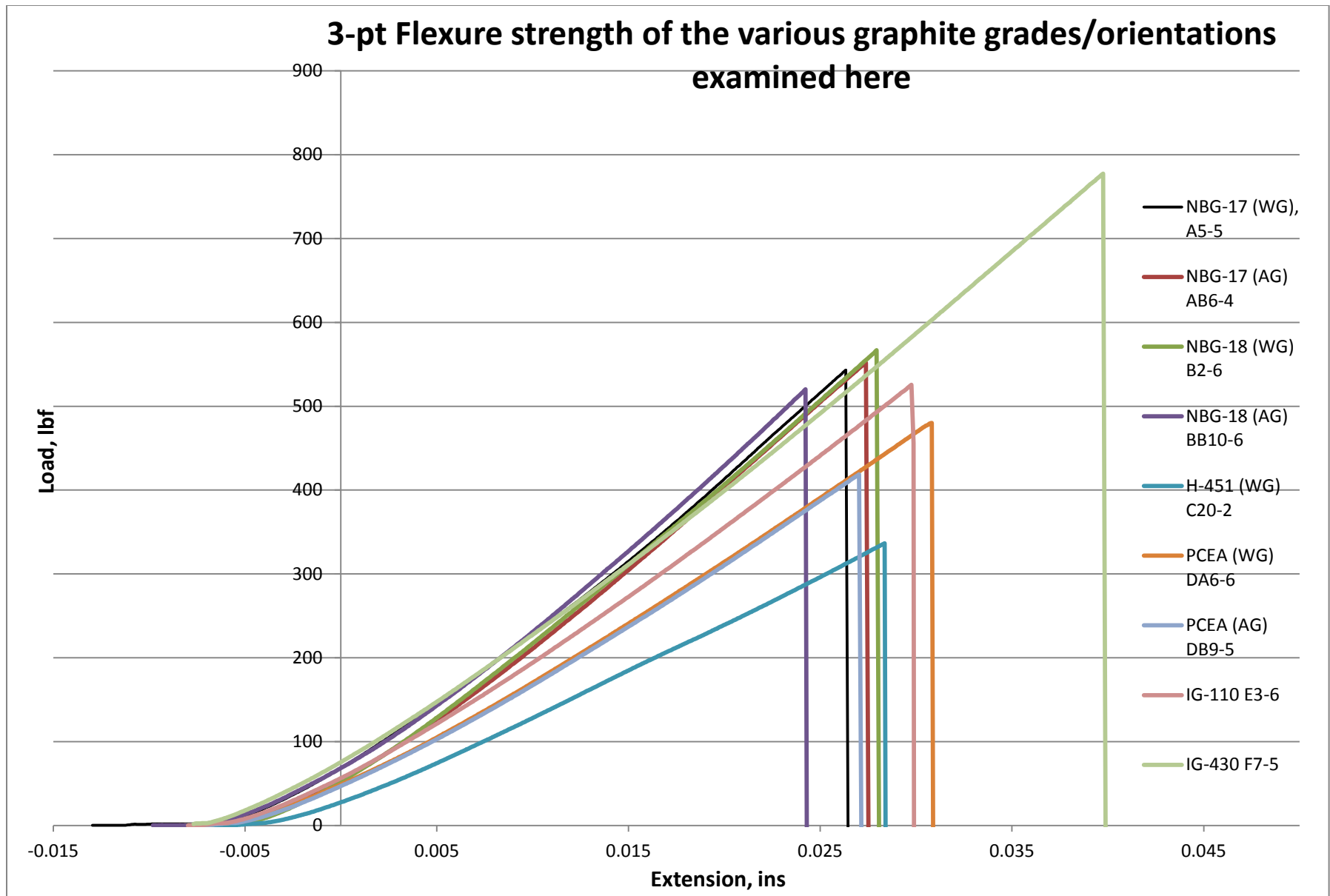


Figure 4 Typical stress-strain curves for 3-pt flexure testing of the AGC-1 graphites

Table 2 3-pt flexure test data for unirradiated grades NBG-17 with- and against-grain

NGNP AGC-1 ZERO DOSE SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER									σ_f (MPa)	σ_f (MPa)
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA	REDUCED DATA SET
10/9/2014	A4-4	12.70	507.26	2256.292	Fracture middle	.05 inches per min	with hole	NBG-17 WG	44.87	
10/9/2014	A2-4	12.70	605.21	2691.974	Fracture middle	.05 inches per min	with hole	NBG-17 WG	53.54	
10/9/2014	A4-6	12.70	494.90	2201.315	Fracture middle	.05 inches per min	with hole	NBG-17 WG	43.78	
10/9/2014	A6-5	12.70	568.06	2526.731	Fracture middle	.05 inches per min	with hole	NBG-17 WG	50.25	
10/9/2014	A2-5	12.69	548.02	2437.593	Fracture middle	.05 inches per min	with hole	NBG-17 WG	48.59	
10/9/2014	A5-6	12.69	521.37	2319.054	Fracture middle	.50 mm per min	with hole	NBG-17 WG	46.23	46.23
10/9/2014	A8-4	12.69	528.76	2351.924	Fracture middle	.50 mm per min	with hole	NBG-17 WG	46.89	46.89
10/9/2014	A5-5	12.69	543.02	2415.353	Fracture middle	.50 mm per min	with hole	NBG-17 WG	48.15	48.15
10/9/2014	A6-6	12.70	557.72	2480.739	Fracture middle	.50 mm per min	with hole	NBG-17 WG	49.34	49.34
10/9/2014	A6-4	12.70	532.78	2369.805	Fracture middle	.50 mm per min	with hole	NBG-17 WG	47.13	47.13
10/13/2014	A7-3	12.69	440.38	1958.81	Fracture middle	.50 mm per min	No hole	NBG-17 WG	39.05	39.05
10/13/2014	A3-4	12.69	461.48	2052.663	Fracture middle	.50 mm per min	No hole	NBG-17 WG	40.92	40.92
10/13/2014	A5-3	12.70	546.50	2430.832	Fracture middle	.50 mm per min	No hole	NBG-17 WG	48.34	48.34
10/13/2014	A2-6	12.70	541.15	2407.035	Fracture middle	.50 mm per min	No hole	NBG-17 WG	47.87	47.87
10/13/2014	A3-3	12.69	581.88	2588.202	Fracture middle	.50 mm per min	No hole	NBG-17 WG	51.60	51.60
10/13/2014	A1-3	12.70	555.79	2472.154	Fracture middle	.50 mm per min	No hole	NBG-17 WG	49.17	49.17
								NBG-17 WG	mean	47.23
								NBG-17 WG	SD	3.70
									mean	46.79
									SD	3.68
10/9/2014	AB10-6	12.69	556.39	2474.823	Fracture middle	.50 mm per min	with hole	NBG-17 AG	49.34	49.34
10/9/2014	AB5-5	12.69	579.62	2578.15	Fracture middle	.50 mm per min	with hole	NBG-17 AG	51.40	51.40
10/9/2014	AB6-6	12.07	561.07	2495.639	Fracture middle	.50 mm per min	with hole	NBG-17 AG	57.82	57.82
10/9/2014	AB6-5	12.70	577.29	2567.786	Fracture middle	.50 mm per min	with hole	NBG-17 AG	51.07	51.07
10/9/2014	AB10-5	12.70	549.80	2445.51	Fracture middle	.50 mm per min	with hole	NBG-17 AG	48.64	48.64
10/10/2014	AB6-4	12.69	552.01	2455.34	Fracture middle	.50 mm per min	with hole	NBG-17 AG	48.95	48.95
10/10/2014	AB8-6	12.69	522.70	2324.97	Fracture middle	.50 mm per min	with hole	NBG-17 AG	46.35	46.35
10/10/2014	AB10-4	12.69	493.57	2195.399	Fracture middle	.50 mm per min	with hole	NBG-17 AG	43.77	43.77
10/10/2014	AB4-5	12.69	503.88	2241.258	Fracture middle	.50 mm per min	with hole	NBG-17 AG	44.68	44.68
10/10/2014	AB8-5	12.69	524.15	2331.419	Fracture middle	.50 mm per min	with hole	NBG-17 AG	46.48	46.48
10/10/2014	AB8-4	12.72	603.24	2683.212	Fracture middle	.50 mm per min	with hole	NBG-17 AG	53.11	53.11
								NBG-17 AG	mean	49.24
								NBG-17 AG	SD	4.05
									mean	49.24
									SD	4.05

Table 3 3-pt flexure test data for unirradiated grades NBG-18 with- and against-grain

NGNP AGC-1									σ_f		σ_f	
ZERO DOSE SPECIMENS												
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER												
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA		REDUCED DATA SET	
10/10/2014	B2-5	12.70	507.33	2256.604	Fracture middle	.50 mm per min	with hole	NBG-18 WG		44.88		44.88
10/10/2014	B4-5	12.69	603.25	2683.256	Fracture middle	.50 mm per min	with hole	NBG-18 WG		53.49		53.49
10/10/2014	B2-4	12.70	464.00	2063.872	Fracture middle	.50 mm per min	with hole	NBG-18 WG		41.05		41.05
10/10/2014	B1-6	12.70	532.60	2369.005	Fracture middle	.50 mm per min	with hole	NBG-18 WG		47.11		47.11
10/10/2014	B1-5	12.69	594.49	2644.292	Fracture middle	.50 mm per min	with hole	NBG-18 WG		52.71		52.71
10/10/2014	B2-6	12.69	566.74	2520.86	Fracture middle	.50 mm per min	with hole	NBG-18 WG		50.25		50.25
10/10/2014	B10-4	12.69	591.46	2630.814	Fracture middle	.50 mm per min	with hole	NBG-18 WG		52.45		52.45
10/10/2014	B10-6	12.69	587.40	2612.755	Fracture middle	.50 mm per min	with hole	NBG-18 WG		52.09		52.09
10/10/2014	B8-4	12.70	534.77	2378.657	Fracture middle	.50 mm per min	with hole	NBG-18 WG		47.31		47.31
10/10/2014	B10-5	12.70	416.44	1852.325	Fracture middle	.50 mm per min	with hole	NBG-18 WG		36.84		36.84
								NBG-18 WG	mean	47.82	mean	47.82
								NBG-18 WG	SD		SD	5.55
10/10/2014	BB6-6	12.70	529.12	2353.526	Fracture middle	.50 mm per min	with hole	NBG-18AG		46.81		46.81
10/10/2014	BB8-4	12.70	657.88	2926.25	Fracture OFF CENTER	.50 mm per min	with hole	NBG-18AG		58.20		
10/10/2014	BB2-6	12.69	529.75	2356.328	Fracture middle	.50 mm per min	with hole	NBG-18AG		46.97		46.97
10/10/2014	BB10-4	12.69	510.87	2272.35	Fracture middle	.50 mm per min	with hole	NBG-18AG		45.30		45.30
10/10/2014	BB1-6	12.68	442.86	1969.841	Fracture middle	.50 mm per min	with hole	NBG-18AG		39.36		39.36
10/10/2014	BB10-6	12.69	520.20	2313.85	Fracture middle	.50 mm per min	with hole	NBG-18AG		46.13		46.13
10/10/2014	BB6-5	12.68	561.01	2495.372	Fracture middle	.50 mm per min	with hole	NBG-18AG		49.86		49.86
10/10/2014	BB4-4	12.70	652.92	2904.188	Fracture middle	.50 mm per min	with hole	NBG-18AG		57.76		57.76
10/10/2014	BB10-5	12.70	640.35	2848.277	Fracture middle	.50 mm per min	with hole	NBG-18AG		56.65		56.65
10/10/2014	BB2-4	12.69	619.89	2757.271	Fracture middle	.50 mm per min	with hole	NBG-18AG		54.97		54.97
10/13/2014	BB6-4	12.70	584.48	2599.767	Fracture middle	.50 mm per min	with hole	NBG-18AG		51.70		51.70
10/13/2014	BB8-5	12.69	626.23	2785.471	Fracture middle	.50 mm per min	with hole	NBG-18AG		55.53		55.53
10/13/2014	BB2-5	12.69	585.60	2604.749	Fracture middle	.50 mm per min	with hole	NBG-18AG		51.93		51.93
								NBG-18AG	mean	50.86	mean	50.25
								NBG-18AG	SD	5.73	SD	5.28

Table 4 3-pt flexure test data for unirradiated grades H-451with-grain

NGNP AGC-1									σ_f		σ_f	
ZERO DOSE SPECIMENS												
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER												
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA		REDUCED DATA SET	
10/10/2014	C14-2	12.69	363.52	1616.937	Fracture middle	.50 mm per min	with hole	H-451 (WG)		32.23		32.23
10/10/2014	C14-1	12.70	287.34	1278.088	Fracture middle	.50 mm per min	with hole	H-451 (WG)		25.42		25.42
10/10/2014	C17-3	12.71	303.34	1349.256	Fracture middle	.50 mm per min	with hole	H-451 (WG)		26.77		26.77
10/10/2014	C12-2	12.71	347.49	1545.636	Fracture middle	.50 mm per min	with hole	H-451 (WG)		30.67		30.67
10/10/2014	C18-1	12.71	313.64	1395.071	Fracture middle	.50 mm per min	with hole	H-451 (WG)		27.68		27.68
10/10/2014	C20-2	12.69	336.50	1496.752	Fracture middle	.50 mm per min	with hole	H-451 (WG)		29.84		29.84
10/10/2014	C20-1	12.72	279.22	1241.971	Fracture middle	.50 mm per min	with hole	H-451 (WG)		24.58		24.58
10/10/2014	C12-1	12.68	344.17	1530.868	Fracture middle	.50 mm per min	with hole	H-451 (WG)		30.59		30.59
10/13/2014	C3-3	12.68	368.62	1639.622	Fracture middle	.50 mm per min	NO HOLE	H-451 (WG)		32.76		32.76
10/13/2014	C3-4	12.70	419.24	1864.78	Fracture middle	.50 mm per min	NO HOLE	H-451 (WG)		37.09		37.09
10/13/2014	C1-3	12.70	373.84	1662.84	Fracture middle	.50 mm per min	NO HOLE	H-451 (WG)		33.07		33.07
								H-451 (WG)	mean	30.06	mean	30.06
								H-451 (WG)	SD	3.73	SD	3.73

Table 5 3-pt flexure test data for unirradiated grades PCEA with- and against-grain

NGNP AGC-1									σ_f		σ_f	
ZERO DOSE SPECIMENS												
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER												
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA		REDUCED DATA SET	
10/13/2014	DA3-6	12.70	542.38	2412.506	Fracture middle	.50 mm per min	with hole	PCEA (WG)		47.98		47.98
10/13/2014	DA1-7	12.70	426.67	1897.828	Fracture middle	.50 mm per min	with hole	PCEA (WG)		37.74		37.74
10/13/2014	DA7-6	12.69	536.37	2385.774	Fracture middle	.50 mm per min	with hole	PCEA (WG)		47.56		47.56
10/13/2014	DA3-7	12.68	511.93	2277.065	Fracture middle	.50 mm per min	with hole	PCEA (WG)		45.50		45.50
10/13/2014	DA1-6	12.70	451.37	2007.694	Fracture middle	.50 mm per min	with hole	PCEA (WG)		39.93		39.93
10/13/2014	DA1-5	12.69	448.01	1992.748	Fracture middle	.50 mm per min	with hole	PCEA (WG)		39.73		39.73
10/13/2014	DA3-5	12.69	462.65	2057.867	Fracture middle	.50 mm per min	with hole	PCEA (WG)		41.02		41.02
10/13/2014	DA6-6	12.70	479.99	2134.996	Fracture middle	.50 mm per min	with hole	PCEA (WG)		42.46		42.46
								PCEA (WG)	mean	42.74	mean	42.74
								PCEA (WG)	SD	3.84	SD	3.84
10/13/2014	DB3-7	12.71	421.42	1874.476	Fracture middle	.50 mm per min	with hole	PCEA (AG)		37.19		37.19
10/13/2014	DB3-6	12.69	457.07	2033.047	Fracture middle	.50 mm per min	with hole	PCEA (AG)		40.53		40.53
10/13/2014	DB3-5	12.70	431.56	1919.579	Fracture middle	.50 mm per min	with hole	PCEA (AG)		38.18		38.18
10/13/2014	DB5-6	12.71	388.42	1727.692	Fracture middle	.50 mm per min	with hole	PCEA (AG)		34.28		34.28
10/13/2014	DB1-5	12.69	424.20	1886.842	Fracture middle	.50 mm per min	with hole	PCEA (AG)		37.61		37.61
10/13/2014	DB1-6	12.70	425.06	1890.667	Fracture middle	.50 mm per min	with hole	PCEA (AG)		37.60		37.60
10/13/2014	DB5-5	12.69	367.93	1636.553	Fracture middle	.50 mm per min	with hole	PCEA (AG)		32.62		32.62
10/13/2014	DB5-7	12.70	438.80	1951.782	Fracture middle	.50 mm per min	with hole	PCEA (AG)		38.82		38.82
10/13/2014	DB1-7	12.69	396.24	1762.476	Fracture middle	.50 mm per min	with hole	PCEA (AG)		35.14		35.14
10/13/2014	DB9-6	12.71	432.88	1925.45	Fracture middle	.50 mm per min	with hole	PCEA (AG)		38.20		38.20
10/13/2014	DB9-5	12.70	418.67	1862.244	Fracture middle	.50 mm per min	with hole	PCEA (AG)		37.04		37.04
10/13/2014	DB9-7	12.71	462.00	2054.976	Fracture middle	.50 mm per min	with hole	PCEA (AG)		40.77		40.77
								PCEA (AG)	mean	37.33	mean	37.33
								PCEA (AG)	SD	2.38	SD	2.38

Table 6 3-pt flexure test data for unirradiated grades IG-110

NGNP AGC-1									σ_f		σ_f	
ZERO DOSE SPECIMENS												
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER												
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA		REDUCED DATA SET	
10/13/2014	E1-7	12.73	504.46	2243.838	Fracture middle	.50 mm per min	with hole	IG-110		44.31		44.31
10/13/2014	E5-5	12.73	516.58	2297.748	Fracture middle	.50 mm per min	with hole	IG-110		45.38		45.38
10/13/2014	E6-4	12.70	467.24	2078.284	Fracture middle	.50 mm per min	with hole	IG-110		41.33		41.33
10/13/2014	E1-6	12.70	563.50	2506.448	Fracture middle	.50 mm per min	with hole	IG-110		49.85		49.85
10/13/2014	E3-6	12.71	525.62	2337.958	Fracture middle	.50 mm per min	with hole	IG-110		46.39		46.39
10/13/2014	E1-5	12.71	517.75	2302.952	Fracture middle	.50 mm per min	with hole	IG-110		45.69		45.69
10/13/2014	E3-7	12.70	541.11	2406.857	Fracture middle	.50 mm per min	with hole	IG-110		47.87		47.87
10/13/2014	E3-5	12.70	562.31	2501.155	Fracture middle	.50 mm per min	with hole	IG-110		49.74		49.74
10/13/2014	E5-7	12.71	542.92	2414.908	Fracture middle	.50 mm per min	with hole	IG-110		47.91		47.91
								IG-110	mean	46.50	mean	46.50
								IG-110	SD	2.72	SD	2.72

Table 7 3-pt flexure test data for unirradiated grade IG-430

NGNP AGC-1									σ_f		σ_f	
ZERO DOSE SPECIMENS												
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER												
Date	Sample ID	Diameter (mm)	Max Force lbf	F (N)	Fracture Location	Speed		GRADE	ALL DATA		REDUCED DATA SET	
10/13/2014	F5-5	12.70	759.37	3377.678	Fracture middle	.50 mm per min	with hole	IG-430		67.18		67.18
10/13/2014	F7-6	12.70	805.97	3584.955	Fracture middle	.50 mm per min	with hole	IG-430		71.30		71.30
10/13/2014	F1-5	12.69	749.53	3333.909	Fracture middle	.50 mm per min	with hole	IG-430		66.46		66.46
10/13/2014	F9-6	12.70	788.00	3505.024	Fracture OFF CENTER	.50 mm per min	with hole	IG-430		69.71		
10/13/2014	F7-5	12.70	777.49	3458.276	Fracture middle	.50 mm per min	with hole	IG-430		68.78		68.78
10/13/2014	F3-6	12.69	782.52	3480.649	Fracture middle	.50 mm per min	with hole	IG-430		69.39		69.39
10/13/2014	F7-7	12.71	819.83	3646.604	Fracture middle	.50 mm per min	with hole	IG-430		72.35		72.35
10/13/2014	F9-5	12.70	750.04	3336.178	Fracture middle	.50 mm per min	with hole	IG-430		66.35		66.35
10/13/2014	F7-3	12.70	777.15	3456.763	Fracture middle	.50 mm per min	NO hole	IG-430		68.75		68.75
10/13/2014	F1-3	12.70	751.09	3340.848	Fracture middle	.50 mm per min	NO hole	IG-430		66.44		66.44
10/13/2014	F3-3	12.70	766.61	3409.881	Fracture middle	.50 mm per min	NO hole	IG-430		67.82		67.82
10/13/2014	F5-4	12.71	769.13	3421.09	Fracture middle	.50 mm per min	NO hole	IG-430		67.88		67.88
								IG-430	mean	68.53	mean	68.43
								IG-430	SD	1.92	SD	1.98

Table 8 summary table of the unirradiated 3-pt flexure strength for the graphites is tested here compared with manufacturer's flexure strength data

GRADE LETTER	Grade	WG/AG	σ_f MEAN	σ_f SD	Manufactutrer's data	test method
			MPa	MPa	MPa	
A	NBG-17	WG per	46.79	3.68	33	4 pt
A	NBG-17	AG par	49.24	4.05	31	4 pt
B	NBG-18	WG per	47.82	5.55	26.4	4 pt
B	NBG-18	AG par	50.25	5.28	27.23	4 pt
C	H-451	WG (par)	30.06	3.73	23.9	4 pt
D	PCEA	WG (par)	42.74	3.84	30	3 pt
D	PCEA	AG (per)	37.33	2.38	26	3 pt
E	IG-110	ISO	46.50	2.72	39.2	4 pt
F	IG-430	ISO	68.43	1.98	53.9	4 pt

3.2.Irradiated Specimen Flexure Strength

The Irradiated graphite results are given in Table 9 through Table 14. The raw data are reported by specimen identification number, no attempt has been made to sort, organize or analyze the data. The full analysis of the data shall be subsequently reported in an ORNL/TM.

The stress-extension (crosshead defection) data for the irradiated specimens were recorded electronically and saved as text files for every specimen tested. The raw data (text files) are available upon request from the author (Burchelltd@ornl.gov).

Typical stress-strain curves for the various grades examined here, in the irradiated condition, are shown in Figure 5.

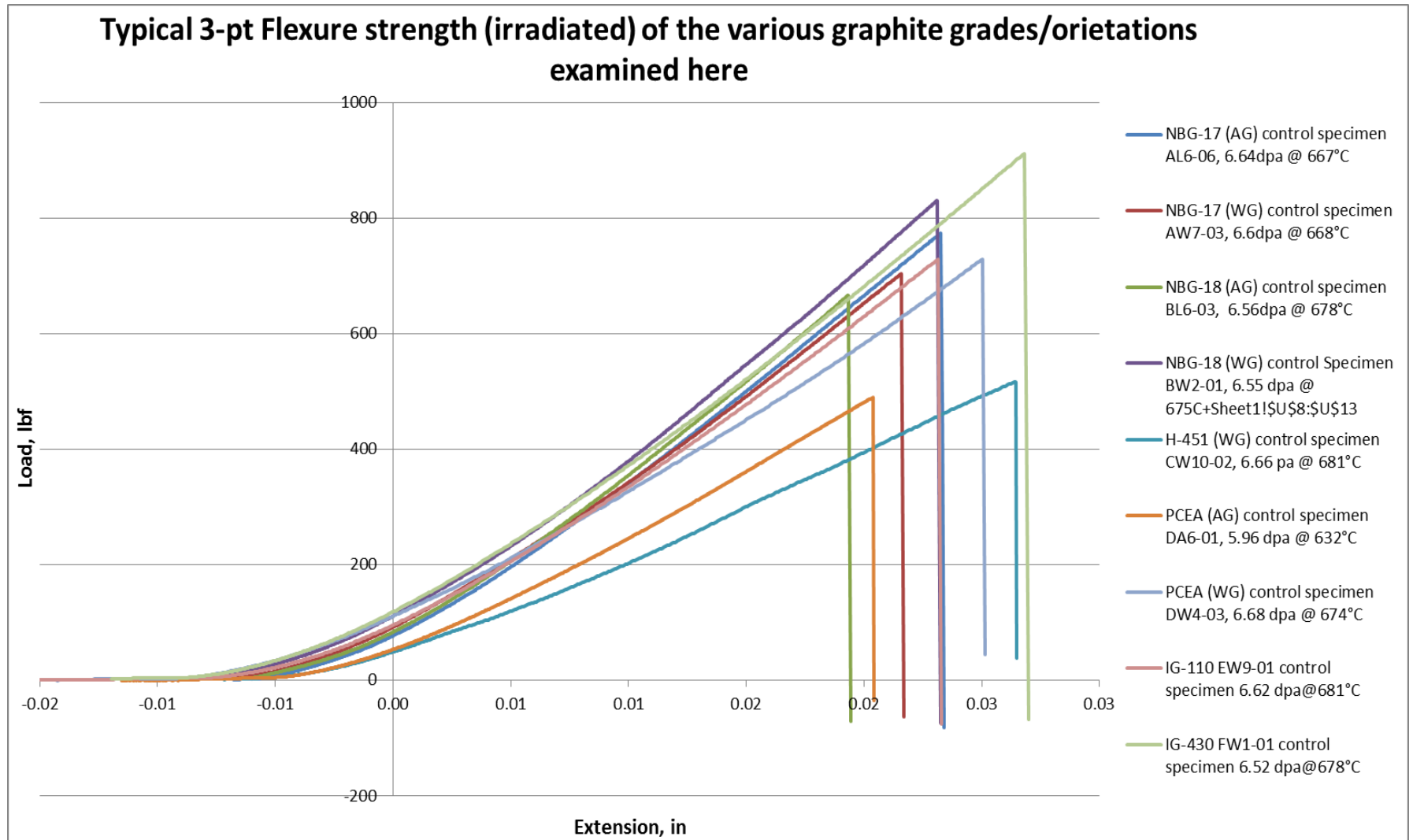


Figure 5 Typical stress-strain curves for 3-pt flexure testing of the irradiated AGC-1 graphite (Similar irradiation conditions)

Table 9 3- Pt-Flexure strength data for Grade NBG-17, with- and against-grain

NGNP AGC-1								σ_f		σ_f		DOSE	Irr. Temp	SPEC TYPE	CREEP STRAIN
IRRADIATED SPECIMENS															
PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER															
Date	Sample ID	Diameter (mm)	lb(f)	F (N)	Fracture Location	Crosshead Speed	GRADE	ALL DATA		REDUCED DATA SET		DPA	°C		%
10/15/2014	AL6-01	12.589	734.82	3268.479	Middle	.50 mm per min	NBG-17 AG		66.73		66.73	6.7	703	Creep	-1.61
10/15/2014	AL6-02	12.685	773.21	3439.238	Middle	.50 mm per min	NBG-17 AG		68.64		68.64	6.4	667	Control	0
10/15/2014	AL8-01	12.686	711.33	3163.996	Middle	.50 mm per min	NBG-17 AG		63.13		63.13	4.65	585	Control	0
10/15/2014	AL8-02	12.630	799.08	3554.308	Middle	.50 mm per min	NBG-17 AG		71.86		71.86	5.33	655	Creep	-1.42
								mean	67.59	mean	67.59				
								SD	3.65	SD	3.65				
10/15/2014	AW1-01	12.627	738.40	3284.403	Off Center	.50 mm per min	NBG-17 WG		66.47			6.17	650	Control	0
10/15/2014	AW1-02	12.648	793.21	3528.198	Middle	.50 mm per min	NBG-17 WG		71.04		71.04	5.44	592	Control	0
10/15/2014	AW1-03	12.706	629.64	2800.639	Middle	.50 mm per min	NBG-17 WG		55.62		55.62	2.87	468	Control	0
10/15/2014	AW2-01	12.590	603.71	2685.302	Middle	.50 mm per min	NBG-17 WG		54.82		54.82	6.51	690	Creep	-1.42
10/15/2014	AW2-02	12.600	645.64	2871.807	Middle	.50 mm per min	NBG-17 WG		58.49		58.49	5.97	668	Creep	-1.13
10/15/2014	AW2-03	12.666	617.46	2746.462	Middle	.50 mm per min	NBG-17 WG		55.06		55.06	3.47	599	Creep	-0.72
10/15/2014	AW4-01	12.672	740.36	3293.121	Middle	.50 mm per min	NBG-17 WG		65.94		65.94	4.78	582	Control	0
10/15/2014	AW4-02	12.715	719.90	3202.115	Middle	.50 mm per min	NBG-17 WG		63.46		63.46	2.86	470	Control	0
10/15/2014	AW4-03	12.632	794.96	3535.982	Middle	.50 mm per min	NBG-17 WG		71.47		71.47	5.47	653	Creep	-1.28
10/16/2014	AW5-01	12.685	823.08	3661.06	Middle	.50 mm per min	NBG-17 WG		73.07		73.07	3.49	592	Creep	-0.9
10/16/2014	AW5-02	12.720	766.09	3407.568	Off Center	.50 mm per min	NBG-17 WG		67.45			2.79	472	Control	0
10/16/2014	AW5-03	12.608	777.01	3456.14	Middle	.50 mm per min	NBG-17 WG		70.25		70.25	5.82	674	Creep	-1.85
10/16/2014	AW6-01	12.688	769.20	3421.402	Middle	.50 mm per min	NBG-17 WG		68.24		68.24	3.42	594	Creep	-1.1
10/16/2014	AW6-02	12.680	734.17	3265.588	Middle	.50 mm per min	NBG-17 WG		65.25		65.25	4.55	587	Control	0
10/16/2014	AW6-03	12.703	669.93	2979.849	Middle	.50 mm per min	NBG-17 WG		59.22		59.22	2.73	473	Control	0
10/16/2014	AW7-01	12.638	702.33	3123.964	Middle	.50 mm per min	NBG-17 WG		63.05		63.05	5.23	656	Control	0
10/16/2014	AW7-03	12.685	703.36	3128.545	Middle	.50 mm per min	NBG-17 WG		62.45		62.45	6.4	678	Control	0
10/16/2014	AW9-01	12.677	760.41	3382.304	Middle	.50 mm per min	NBG-17 WG		67.64		67.64	5.61	617	Control	0
10/16/2014	AW9-03	12.580	729.55	3245.038	Middle	.50 mm per min	NBG-17 WG		66.40		66.40	6.66	712	Creep	-2.01
10/16/2014	AW10-01	12.591	761.76	3388.308	Off Center	.50 mm per min	NBG-17 WG		69.15			6.09	677	Creep	-1.47
	AW10-02	12.685	N/A	N/A	Used for Metallography	.50 mm per min	NBG-17 WG						667		
10/17/2014	AW10-03	12.681	732.11	3256.425	Middle	.50 mm per min	NBG-17 WG		65.06		65.06	5.43	594	Control	0
10/17/2014	AW12-01	12.726	740.08	3291.876	Middle	.50 mm per min	NBG-17 WG		65.07		65.07	2.85	470	Control	0
10/17/2014	AW12-03	12.598	712.81	3170.579	Middle	.50 mm per min	NBG-17 WG		64.61		64.61	6	670	Creep	-1.89
10/17/2014	AW13-01	12.683	689.04	3064.85	Middle	.50 mm per min	NBG-17 WG		61.20		61.20	3.51	593	Creep	-1.09
10/17/2014	AW13-02	12.696	704.09	3131.792	Off Center	.50 mm per min	NBG-17 WG		62.34			5.35	597	Control	0
								mean	64.51	mean	64.16				
								SD	5.05	SD	5.34				

Table 10 3- Pt-Flexure strength data for Grade NBG-18 with- and against-grain

NGNP AGC-1 IRRADIATED SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER									σ_f (MPa)	σ_f (MPa)	DOSE	Irr. Temp	SPEC TYPE	CREEP STRAIN
Date	Sample ID	Diameter (mm)		F (N)	Fracture Location	Crosshead Speed		GRADE	ALL DATA	REDUCED DATA SET	DPA	°C		%
10/17/2014	BL6-02	12.574	789.96	3513.742	Middle	.50 mm per min		NBG-18 AG	72.01	72.01	6.78	714	Creep	-2.07
10/17/2014	BL6-03	12.701	666.71	2965.526	Middle	.50 mm per min		NBG-18 AG	58.96	58.96	6.56	678	Control	0
10/17/2014	BL7-01	12.724	743.86	3308.689	Middle	.50 mm per min		NBG-18 AG	65.43	65.43	3.39	505	Control	0
10/17/2014	BL7-02	12.672	943.79	4197.978	Middle	.50 mm per min		NBG-18 AG	84.05	84.05	3.96	559	Creep	-1.06
									mean	70.11	mean	70.11		
									SD	10.71	SD	10.71		
10/17/2014	BW1-01	12.642	723.01	3215.948	Middle	.50 mm per min		NBG-18 WG	64.84	64.84	6.34	664	Control	0
10/17/2014	BW1-02	12.675	838.85	3731.205	Middle	.50 mm per min		NBG-18 WG	74.65	74.65	3.93	597	Creep	-0.72
10/17/2014	BW1-03	12.575	852.28	3790.941	Middle	.50 mm per min		NBG-18 WG	77.66	77.66	6.63	700	Creep	-1.35
10/17/2014	BW2-01	12.662	830.59	3694.464	Middle	.50 mm per min		NBG-18 WG	74.15	74.15	6.55	675	Control	0
10/17/2014	BW2-02	12.662	964.19	4288.717	Off Center	.50 mm per min		NBG-18 WG	86.06		5.15	582	Control	0
10/17/2014	BW2-03	12.562	820.88	3651.274	Middle	.50 mm per min		NBG-18 WG	75.04	75.04	6.8	709	Creep	-1.72
10/17/2014	BW3-01	12.613	745.65	3316.651	Middle	.50 mm per min		NBG-18 WG	67.34	67.34	5.76	665	Creep	-1.38
10/17/2014	BW3-02	12.626	802.19	3568.141	Middle	.50 mm per min		NBG-18 WG	72.21	72.21	5.72	611	Control	0
10/17/2014	BW3-03	12.689	736.96	3277.998	Middle	.50 mm per min		NBG-18 WG	65.36	65.36	5.63	617	Control	0
10/17/2014	BW5-01	12.694	672.32	2990.479	Middle	.50 mm per min		NBG-18 WG	59.56	59.56	4.66	585	Control	0
10/17/2014	BW5-02	12.591	811.67	3610.308	Middle	.50 mm per min		NBG-18 WG	73.68	73.68	6.19	671	Creep	-1.19
10/17/2014	BW5-03	12.593	745.85	3317.541	Middle	.50 mm per min		NBG-18 WG	67.68	67.68	6.13	678	Creep	-1.82
10/17/2014	BW7-01	12.625	594.90	2646.115	Middle	.50 mm per min		NBG-18 WG	53.58	53.58	5.38	656	Creep	-1.64
10/17/2014	BW7-02	12.666	815.62	3627.878	Middle	.50 mm per min		NBG-18 WG	72.73	72.73	5.95	658	Control	0
10/20/2014	BW7-03	12.705	942.73	4193.263	Middle	.50 mm per min		NBG-18 WG	83.30	83.30	3.24	509	Control	0
10/20/2014	BW8-01	12.591	824.57	3667.687	Middle	.50 mm per min		NBG-18 WG	74.86	74.86	6.3	698	Creep	-1.2
10/20/2014	BW8-02	12.631	711.03	3162.661	Middle	.50 mm per min		NBG-18 WG	63.94	63.94	5.76	675	Creep	-1.48
10/20/2014	BW9-01	12.691	776.20	3452.538	Middle	.50 mm per min		NBG-18 WG	68.80	68.80	5.85	638	Control	0
10/20/2014	BW9-02	12.683	740.84	3295.256	Middle	.50 mm per min		NBG-18 WG	65.81	65.81	5.01	585	Control	0
10/20/2014	BW9-03	12.704	752.59	3347.52	Middle	.50 mm per min		NBG-18 WG	66.51	66.51	3.41	505	Control	0
10/20/2014	BW10-01	12.599	821.52	3654.121	Off Center	.50 mm per min		NBG-18 WG	74.44		6.28	686	Creep	-1.49
10/20/2014	BW10-02	12.625	849.99	3780.756	Middle	.50 mm per min		NBG-18 WG	76.55	76.55	5.62	668	Creep	-1.37
	BW10-03	12.689	N/A	N/A	Used for Metallography	.50 mm per min		NBG-18 WG			6.51	674	Control	0
10/20/2014	BW11-01	12.668	732.89	3259.895	Middle	.50 mm per min		NBG-18 WG	65.33	65.33	5.72	613	Control	0
10/20/2014	BW11-02	12.673	740.55	3293.966	Middle	.50 mm per min		NBG-18 WG	65.94	65.94	3.95	599	Creep	-0.9
10/20/2014	BW12-01	12.605	724.92	3224.444	Middle	.50 mm per min		NBG-18 WG	65.59	65.59	6.21	674	Creep	-1.8
10/20/2014	BW12-02	12.707	735.95	3273.506	Middle	.50 mm per min		NBG-18 WG	65.00	65.00	3.41	504	Control	0
10/20/2014	BW12-03	12.690	729.16	3243.304	Middle	.50 mm per min		NBG-18 WG	64.66	64.66	5.22	599	Control	0
									mean	69.82	mean	68.99		
									SD	7.04	SD	6.41		

Table 11 3- Pt-Flexure strength data for Grade H-451 with-grain

NGNP AGC-1							GRADE	σ_f (MPa)				DOSE	Irr. Temp	SPEC TYPE	CREEP STRAIN
IRRADIATED SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER															
Date	Sample ID	Diameter (mm)	F lb(f)	F (N)	Fracture Location	Crosshead Speed	ALL DATA		REDUCED DATA SET		DPA	°C		%	
10/20/2014	CW7-01	12.634	460.35	2047.637	Middle	.50 mm per min	H-451 (WG)		41.36		41.36	6.84	706	Creep	-1.89
10/20/2014	CW7-03	12.656	472.09	2099.856	Middle	.50 mm per min	H-451 (WG)		42.20		42.20	5.41	649	Creep	-1.35
10/20/2014	CW8-02	12.562	442.18	1966.817	Middle	.50 mm per min	H-451 (WG)		40.42		40.42	6.7	674	Control	0
10/20/2014	CW8-03	12.614	365.59	1626.144	Middle	.50 mm per min	H-451 (WG)		33.01		33.01	4.76	580	Control	0
10/20/2014	CW9-01	12.662	436.65	1942.219	Middle	.50 mm per min	H-451 (WG)		38.98		38.98	6.42	683	Creep	unknown
10/20/2014	CW9-03	12.709	430.82	1916.287	Middle	.50 mm per min	H-451 (WG)		38.03		38.03	6.81	712	Creep	-3.09
10/20/2014	CW10-01	12.695	573.40	2550.483	Middle	.50 mm per min	H-451 (WG)		50.78		50.78	6.47	697	Creep	-2.61
10/20/2014	CW10-02	12.554	516.51	2297.436	Middle	.50 mm per min	H-451 (WG)		47.31		47.31	6.66	681	Control	0
10/20/2014	CW10-03	12.558	458.85	2040.965	Middle	.50 mm per min	H-451 (WG)		41.98		41.98	6.09	657	Control	0
10/20/2014	CW11-01	12.666	508.91	2263.632	Off Center	.50 mm per min	H-451 (WG)		45.38			4.91	642	Creep	-1.21
10/21/2014	CW11-02	12.680	429.61	1910.905	Middle	.50 mm per min	H-451 (WG)		38.18		38.18	4.6	628	Creep	-1.19
10/21/2014	CW12-02	12.671	465.74	2071.612	Middle	.50 mm per min	H-451 (WG)		41.48		41.48	5	641	Creep	1.79
10/21/2014	CW13-01	12.623	519.08	2308.868	Middle	.50 mm per min	H-451 (WG)		46.77		46.77	4.24	567	Control	0
10/21/2014	CW13-02	12.670	566.64	2520.415	Middle	.50 mm per min	H-451 (WG)		50.49		50.49	6.92	708	Control	0
10/21/2014	CW13-03	12.678	563.61	2506.937	Middle	.50 mm per min	H-451 (WG)		50.12		50.12	5.46	653	Creep	-2.25
10/21/2014	CW14-01	12.696	659.73	2934.479	Middle	.50 mm per min	H-451 (WG)		58.42		58.42	4.64	627	Creep	-1.42
10/21/2014	CW14-02	12.610	515.47	2292.811	Middle	.50 mm per min	H-451 (WG)		46.58		46.58	4.74	582	Control	0
								mean	44.21		mean	44.13			
								SD	6.17		SD	6.36			

Table 12 3- Pt-Flexure strength data for Grade PCEA with- and against-grain

NGNP AGC-1 IRRADIATED SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER									σ_f (MPa)	σ_f (MPa)		Irr. Temp	SPEC TYPE	CREEP STRAIN		
Date	Sample ID	Diameter (mm)		F (N)	Fracture Location	Crosshead Speed		GRADE	ALL DATA		REDUCED DATA SET		DPA	°C		%
21-10-14	DA601	12.546	489.43	2176.985	Middle	.50 mm per min		PCEA (AG)		44.91		44.91	5.96	632	Control	0
21-10-14	DA602	12.608	511.75	2276.264	Middle	.50 mm per min		PCEA (AG)		46.27		46.27	6.37	680	Creep	-1.878
21-10-14	DA701	12.675	504.34	2243.304	Middle	.50 mm per min		PCEA (AG)		44.88		44.88	4.17	612	Creep	-1.168
21-10-14	DA702	12.658	748.17	3327.86	Middle	.50 mm per min		PCEA (AG)		66.84		66.84	3.72	538	Control	0
									mean	50.72	mean	50.72				
									SD	10.77	SD	10.77				
21-10-14	DW1-01	12.593	687.74	3059.068	Middle	.50 mm per min		PCEA (WG)		62.41		62.41	6.73	706	Creep	-1.629
21-10-14	DW1-02	12.643	826.83	3677.74	Middle	.50 mm per min		PCEA (WG)		74.14		74.14	3.88	534	Control	0
21-10-14	DW1-03	12.673	929.01	4132.236	Middle	.50 mm per min		PCEA (WG)		82.72		82.72	4.36	606	Creep	-0.953
21-10-14	DW2-01	12.525	736.39	3275.463	Middle	.50 mm per min		PCEA (WG)		67.91		67.91	6.49	672	Control	0
21-10-14	DW2-02	12.546	741.92	3300.06	Middle	.50 mm per min		PCEA (WG)		68.08		68.08	5.96	634	Control	0
21-10-14	DW2-03	12.634	757.52	3369.449	Middle	.50 mm per min		PCEA (WG)		68.07		68.07	3.91	533	Control	0
21-10-14	DW3-01	12.614	742.41	3302.24	Middle	.50 mm per min		PCEA (WG)		67.03		67.03	6.8	711	Creep	-2.043
21-10-14	DW3-02	12.639	849.98	3780.711	Middle	.50 mm per min		PCEA (WG)		76.29		76.29	6.02	670	Creep	-1.747
21-10-14	DW3-03	12.681	784.42	3489.1	Middle	.50 mm per min		PCEA (WG)		69.71		69.71	4.38	609	Creep	-1.321
21-10-14	DW4-01	12.571	820.60	3650.029	Off Center	.50 mm per min		PCEA (WG)		74.86		74.86	5.47	594	Control	0
21-10-14	DW4-03	12.511	729.21	3243.526	Middle	.50 mm per min		PCEA (WG)		67.47		67.47	6.68	674	Control	0
21-10-14	DW5-01	12.630	725.15	3225.467	Middle	.50 mm per min		PCEA (WG)		65.23		65.23	3.91	534	Control	0
21-10-14	DW5-02	12.670	822.07	3656.567	Middle	.50 mm per min		PCEA (WG)		73.25		73.25	5.66	669	Creep	-2.423
22-10-14	DW5-03	12.553	839.26	3733.028	Middle	.50 mm per min		PCEA (WG)		76.89		76.89	5.88	638	Control	0
22-10-14	DW6-01	12.600	811.30	3608.662	Middle	.50 mm per min		PCEA (WG)		73.49		73.49	5.02	585	Control	0
22-10-14	DW6-02	12.637	667.41	2968.64	Off Center	.50 mm per min		PCEA (WG)		59.93			5.97	679	Creep	-1.608
22-10-14	DW6-03	12.625	829.47	3689.483	Off Center	.50 mm per min		PCEA (WG)		74.69		74.69	6.52	714	Creep	-1.661
22-10-14	DW7-01	12.537	818.22	3639.443	Middle	.50 mm per min		PCEA (WG)		75.25		75.25	6.27	679	Control	0
22-10-14	DW7-02	12.588	846.49	3765.188	Middle	.50 mm per min		PCEA (WG)		76.90		76.90	5.5	618	Control	0
22-10-14	DW7-03	12.636	847.97	3771.771	Off Center	.50 mm per min		PCEA (WG)		76.15		76.15	6.55	706	Creep	-2.040
22-10-14	DW8-01	12.655	855.80	3806.598	Middle	.50 mm per min		PCEA (WG)		76.53		76.53	5.87	674	Creep	-1.849
22-10-14	DW8-02	12.691	703.69	3130.013	Middle	.50 mm per min		PCEA (WG)		62.39		62.39	4.25	611	Creep	-1.245
22-10-14	DW8-03	12.545	776.51	3453.916	Center then off to side	.50 mm per min		PCEA (WG)		71.27		71.27	6.24	670	Control	0
22-10-14	DW9-01	12.589	796.61	3543.321	Middle	.50 mm per min		PCEA (WG)		72.35		72.35	5.33	597	Control	0
22-10-14	DW9-03	12.634	843.68	3752.689	Middle	.50 mm per min		PCEA (WG)		75.80		75.80	6.83	710	Creep	-2.423
22-10-14	DW10-01	12.680	754.15	3354.459	Middle	.50 mm per min		PCEA (WG)		67.03		67.03	4.39	610	Creep	-1.592
22-10-14	DW10-02	12.626	714.36	3177.473	Middle	.50 mm per min		PCEA (WG)		64.31		64.31	3.88	534	Control	0
22-10-14	DW11-01	12.654	715.06	3180.587	Middle	.50 mm per min		PCEA (WG)		63.95		63.95	6.32	687	Creep	-2.538
									mean	70.86	mean	71.26				
									SD	5.63	SD	5.30				

Table 13 3- Pt-Flexure strength data for Grade IG-110

NGNP AGC-1 IRRADIATED SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER								σ_f		DOSE	Irr. Temp	SPEC TYPE	CREEP STRAIN
Date	Sample ID	Diameter (mm)		F (N)	Fracture Location	Crosshead Speed	GRADE	REDUCED DATA SET		DPA	°C		%
10/22/2014	EW10-01	12.564	647.62	2880.614	Center then off to side	.50 mm per min	IG-110		59.17	5.11	582	Control	0.000
10/22/2014	EW10-02	12.666	636.00	2828.928	Center then off to side	.50 mm per min	IG-110		56.71	6.69	713	Creep	-2.756
10/22/2014	EW10-03	12.519	632.25	2812.248	Center then off to side	.50 mm per min	IG-110		58.39	6.43	678	Control	0.000
10/27/2014	EW2-01	12.649	751.62	3343.206	Middle	.50 mm per min	IG-110		67.29	5.11	635	Creep	-1.323
10/27/2014	EW2-02	12.664	633.78	2819.053	Center then off to side	.50 mm per min	IG-110		56.55	4.75	621	Creep	-1.210
10/27/2014	EW2-03	12.606	743.89	3308.823	Middle	.50 mm per min	IG-110		67.29	4.36	562	Control	0.000
10/27/2014	EW4-01	12.677	675.22	3003.379	Center then off to side	.50 mm per min	IG-110		60.05	4.69	628	Creep	-1.919
10/27/2014	EW4-02	12.655	641.64	2854.015	Center then off to side	.50 mm per min	IG-110		57.36	6.54	693	Creep	-2.778
10/22/2014	EW5-01	12.638	626.31	2785.827	Broke to side at hole	.50 mm per min	IG-110			6.24	674	Creep	-2.120
10/27/2014	EW5-02	12.534	668.25	2972.376	Center then off to side	.50 mm per min	IG-110		61.50	6.18	653	Control	0.000
10/22/2014	EW5-03	12.545	753.79	3352.858	Center then off to side	.50 mm per min	IG-110		69.18	5.76	613	Control	0.000
10/27/2014	EW6-01	12.683	683.27	3039.185	Center then off to side	.50 mm per min	IG-110		60.69	5.05	642	Creep	-2.170
10/22/2014	EW6-03	12.623	599.37	2665.998	Middle	.50 mm per min	IG-110		54.00	6.63	713	Creep	-1.937
10/27/2014	EW7-01	12.630	670.45	2982.162	Center then off to side	.50 mm per min	IG-110		60.30	6.42	708	Creep	-1.823
10/22/2014	EW8-01	12.527	685.99	3051.284	Center then off to side	.50 mm per min	IG-110		63.24	6.13	671	Control	0.000
10/22/2014	EW8-02	12.655	569.78	2534.381	Center then off to side	.50 mm per min	IG-110		50.94	6.77	712	Creep	-2.526
10/27/2014	EW8-03	12.668	755.08	3358.596	Center then off to side	.50 mm per min	IG-110		67.31	3.82	601	Creep	-1.312
10/27/2014	EW9-01	12.515	728.51	3240.412	Center then off to side	.50 mm per min	IG-110		67.35	6.62	681	Control	0.000
10/27/2014	EW9-02	12.622	719.74	3201.404	Center then off to side	.50 mm per min	IG-110		64.86	3.31	507	Control	0.000
10/22/2014	EW9-03	12.661	745.23	3314.783	Center then off to side	.50 mm per min	IG-110		66.53	5.75	666	Creep	-2.308

Table 14 3- Pt-Flexure strength data for Grade IG-430

NGNP AGC-1							σ_f		σ_f		DOSE	Irr. Temp	SPEC TYPE	CREEP STRAIN	
IRRADIATED SPECIMENS PERFORMED BY ASHLI CLARK AND MICHAEL MCALISTER															
Date	Sample ID	Diameter (mm)		F (N)	Fracture Location	Crosshead Speed	GRADE	ALL DATA		REDUCED DATA SET		DPA	°C		%
27-10-14	FW1-01	12.619	911.83	4055.82	Center then off to side	.50 mm per min	IG-430		82.22		82.22	6.52	678	Control	0.000
28-10-14	FW1-03	12.563	762.16	3390.088	Center then off to side	.50 mm per min	IG-430		69.65		69.65	6.06	656	Control	0.000
28-10-14	FW2-01	12.565	1078.05	4795.166	Center then off to side	.50 mm per min	IG-430		98.47		98.47	6.87	708	Creep	-5.108
28-10-14	FW2-02	12.628	760.03	3380.613	Center then off to side	.50 mm per min	IG-430		68.40		68.40	6.79	708	Creep	-3.389
28-10-14	FW2-03	12.634	1088.52	4841.737	Center then off to side	.50 mm per min	IG-430		97.80		97.80	6.61	672	Control	0.000
28-10-14	FW3-01	12.654	1037.60	4615.245	Center then off to side	.50 mm per min	IG-430		92.80		92.80	5.14	639	Creep	-3.077
28-10-14	FW3-02	12.552	934.03	4154.565	Center then off to side	.50 mm per min	IG-430		85.58		85.58	4.78	626	Creep	-3.081
28-10-14	FW3-03	12.601	1042.19	4635.661	Center then off to side	.50 mm per min	IG-430		94.39		94.39	6.73	677	Control	0.000
28-10-14	FW4-01	12.648	940.82	4184.767	Center then off to side	.50 mm per min	IG-430		84.25		84.25	5.12	580	Control	0.000
28-10-14	FW4-02	12.651	821.27	3653.009	Center then off to side	.50 mm per min	IG-430		73.50		73.50	5.72	662	Creep	-2.175
28-10-14	FW4-03	12.682	819.21	3643.846	Center then off to side	.50 mm per min	IG-430		72.79		72.79	5.12	580	Control	0.000
28-10-14	FW5-01	12.685	991.54	4410.37	Center then off to side	.50 mm per min	IG-430		88.02		88.02	6.58	693	Creep	-3.659
28-10-14	FW5-02	12.709	1056.85	4700.869	Center then off to side	.50 mm per min	IG-430		93.29		93.29	5.15	639	Creep	-2.547
30-10-14	FW5-03	12.580	1045.35	4649.717	Center then off to side	.50 mm per min	IG-430		95.14		95.14	4.38	609	Creep	-2.678
30-10-14	FW7-01	12.559	927.42	4125.164	Center then off to side	.50 mm per min	IG-430		84.84		84.84	6.22	653	Control	0.000
30-10-14	FW7-02	12.638	1045.78	4651.629	Middle	.50 mm per min	IG-430		93.89		93.89	4.37	564	Control	0.000
30-10-14	FW7-03	12.649	1030.62	4584.198	Center then off to side	.50 mm per min	IG-430		92.27		92.27	2.78	472	Control	0.000
30-10-14	FW8-01	12.662	790.05	3514.142	Center then off to side	.50 mm per min	IG-430		70.52		70.52	6.15	688	Creep	-2.362
30-10-14	FW8-02	12.660	875.97	3896.315	Center then off to side	.50 mm per min	IG-430		78.23		78.23	6.59	707	Creep	-4.065
30-10-14	FW9-01	12.604	1109.52	4935.145	Center then off to side	.50 mm per min	IG-430		100.41		100.41	4.3	612	Creep	-2.700
30-10-14	FW9-02	12.664	844.22	3755.091	Center then off to side	.50 mm per min	IG-430		75.32		75.32	3.87	602	Creep	-2.422
30-10-14	FW9-03	12.667	855.27	3804.241	Center then off to side	.50 mm per min	IG-430		76.24		76.24	5.74	639	Control	0.000
30-10-14	FW10-01	12.576	878.54	3907.746	Center then off to side	.50 mm per min	IG-430		80.04		80.04	6.28	670	Control	0.000
30-10-14	FW10-02	12.577	1119.04	4977.49	Center then off to side	.50 mm per min	IG-430		101.92		101.92	3.8	537	Control	0.000
30-10-14	FW10-03	12.690	566.23	2518.591	Broke to side at hole	.50 mm per min	IG-430		50.21			3.32	508	Control	0.000
30-10-14	FW11-01	12.678	729.94	3246.773	Broke to side at hole	.50 mm per min	IG-430		64.91			6.59	716	Creep	-2.900
30-10-14	FW11-02	12.688	1012.55	4503.822	Center then off to side	.50 mm per min	IG-430		89.84		89.84	5.51	669	Creep	-1.894
30-10-14	FW11-03	12.554	699.31	3110.531	Center then off to side	.50 mm per min	IG-430		64.04		64.04	4.91	587	Control	0.000
30-10-14	FW12-01	12.697	947.40	4214.035	Center then off to side	.50 mm per min	IG-430		83.86		83.86	6.72	714	Creep	-3.487
30-10-14	FW13-01	12.646	1089.25	4844.984	Center then off to side	.50 mm per min	IG-430		97.61		97.61	6.43	697	Creep	-3.087
								mean	83.35	mean	85.19				
								SD	12.78	SD	10.89				

The irradiated specimens were stronger than their unirradiated counterparts, as expected. The data are at too high a dose to see the initial rapid strength increase, commonly (attributed to dislocation pinning). Post turn-around strength loss is only seen for IG-430 controls, as discussed in a subsequent TM report.

4. Quality Assurance

The activities described here were conducted in accordance with the applicable requirements of the ASME/NQA-1-2008 national standard entitled Quality Assurance Requirements for Nuclear Facility Applications. Project and activity-specific information concerning ORNL's application of the standard's requirements is provided in Document #QAP-ORNL-NGNP-01 titled Quality Assurance Plan for the Next Generation Nuclear Plant Materials Program at Oak Ridge National Laboratory.

5. Conclusions

Here we have reported the results of 3pt flexure testing of the AGC-1 specimens (162), along with 103 unirradiated specimens to provide reference data. The data are reported, but no attempt at analysis has been made. Full data analysis, i.e., the effect of irradiation and irradiation induced creep strain on the flexure-strength; fractional changes in strength, etc. shall follow in an ORNL/TM later this year.

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7. Distribution

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