OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37830

September 5, 1979

Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. M. Vagins

Dear Milt:

Attached are three tables summarizing results on Charpy V-notch tests from 61W, 62W and 63W weldments which are part of the specimens in the second HSST 4T irradiation series.

These lists include the unirradiated control specimens and selected results from the irradiated specimens. Those specimens which were identified for testing during the meeting on July 5, 1979, are identified with a check mark (✓) in the first column. The remainder of the specimens were tested at an earlier time, and most of them meet our criteria for fluence and irradiation temperature or are sufficiently close to be of interest.

Please let me know if you have any questions.

Sincerely yours,

Grady

G. D. Whitman, Manager
Heavy-Section Steel Technology
Program

GDW:spf
Attachments (3)

cc: D. A. Canonico
J. R. Dougan

Table 1. Effect of Irradiation[a] on the Loss of Upper Shelf Charpy V Notch Impact Toughness for 61 W Weld Metal[b]

Specimen Number	Irradiation: Total Fluence[c] (10^{-18} n/cm^2)	Irradiation: Temperature Range[d] °C	Irradiation: Temperature Range[d] °F	Test Temperature[e] °C	Test Temperature[e] °F	Fracture Energy J	Fracture Energy ft/lb	Lateral Expansion mm	Lateral Expansion in.	Fracture Appearance % Ductile	Loss of Upper Shelf Energy, %: Actual	Loss of Upper Shelf Energy, %: Predicted[f] 0.05%	Loss of Upper Shelf Energy, %: Predicted[f] 0.28%	Fast Drop in Load[g] %
61 W-269	0			−18	0	42.5	31.5	0.74	0.029	40				78
270	0			93	200	76	56	1.52	0.060	100				0
271	0			149	300	82	60.5	1.68	0.066	100				0
272	0			27	80	70.5	52	1.37	0.054	85				30
273	0			4	40	54	40	0.89	0.035	45				60
274	0			54	130	83.5	61.5	1.47	0.058	100				0
275	0			232	450	86	63.5	1.68	0.066	100				0
276	0			93	200	89	65.5	1.63	0.064	100				0
											Average Upper Shelf Energy = 83.5 J (61.4 ft/lb)			
208	11.2	290/305	555/580	177	350	57	42	1.04	0.041	100	32	19.5	43	ND
209	10.0	290/305	555/580	177	350	66.5	49	1.19	0.047	100	20	19	42	ND
210	9.1	290/305	555/580	288	550	72	53	1.24	0.049	100	14	18.5	42	ND
211	8.5	290/305	555/580	177	350	70.5	52	1.24	0.049	100	15	18	42	ND
212	8.2	290/305	555/580	177	350	76	56	1.27	0.050	100	9	18	41	ND
213	8.2	290/305	555/580	288	550	79	58	1.45	0.057	100	6	18	41	ND
214	8.5	290/305	555/580	288	550	73	54	1.17	0.046	100	12	18	41	ND
218	13.7	305/315	580/600	54	130	38	28	0.48	0.019	95	NU	20.5	45	60
219	11.1	305/315	580/600	No Test − Incorrectly Notched										
220	10.0	305/315	580/600	A								19	42	
221	10.0	305/315	580/600	A								19	42	
222	11.1	305/315	580/600	149	300	68	50	1.09	0.043	100	19	19.5	43	0
223	13.7	305/315	580/600	93	200	59.5	44	0.94	0.037	100	NU	20.5	45	0
224	8.3	290/300	555/575	66	150	51.5	38	0.76	0.030	100	NU	18	41	40
											Average Upper Shelf Energy[h] After Irradiation = 70.4 J (51.8 ft/lb)			

[a]Only test data from specimens irradiated within the temperature range 290–315°C (555–600°F) were selected for determining the effect of irradiation on upper shelf energy.

[b]Average Cu content reported by Westinghouse Electric Company 0.28% (based on five analyses which ranged from 0.26 to 0.31).

[c]Total Fluence is sum of dose in forward and reverse positions of the capsule during irradiation.

[d]Temperature range includes the irradiation temperature in both forward and reverse positions of the capsule.

[e]A means specimens are available − they have not been tested.

[f]Predicted loss of Charpy V notch upper shelf energy from Regulatory Guide 1.99 (Revision 1 April 1977) − 0.05% Cu (lower bound) and Cu content of weld metal 61 W.

[g]Fast drop in load is determined from instrumented Charpy V notch test. A zero percent drop corresponds with onset of upper shelf. ND = not determined.

[h]Charpy V notch impact tests made at 149–288°C (300–550°F) used to determine average upper shelf energy values, NU results not used in calculation.

Table 2. Effect of Irradiation[a] on the Loss of Upper Shelf Charpy V Notch Impact Toughness for 62 W Weld Metal[b]

Number	Irradiation			Test		Fracture		Lateral		Fracture	Loss of Upper Shelf Energy, %			Fast Drop
	Fluence[c]	Range[d]										Predicted[f]		
	(10^{-18} n/cm^2)	°C	°F	°C	°F	J	ft/lb	mm	in.	% Ductile	Actual	0.05%	0.19%	%
62 W-221	0			10	50	59	43.5	1.02	0.040	80				40
222	0			93	200	90	66.5	1.63	0.064	100				0
234	0			160	320	90	66.5	1.68	0.066	100				0
264	0			39	103	86	63.5	1.50	0.059	100				NT
265	0			−46	−50	19	14	0.31	0.012	18				87
266	0			−18	0	34	25	0.56	0.022	40				75
269	0			24	75	70	51.5	1.19	0.047	95				25
276	0			66	150	86	63.5	1.55	0.061	100				0
278	0			127	260	92	68	1.75	0.069	100				0
279	0			232	450	95.5	70.5	1.55	0.061	100				0
											Average Upper Shelf Energy = 90.3 J (66.4 ft/lb)			
305	12.6	285/300	545/570	177	350	80	59	1.37	0.054	100	11	20	36	ND
✓306	11.2	285/300	545/570	177	350	84	62	1.30	0.051	100	7	19.5	35	ND
✓307	10.2	285/300	545/570	288	550	78.5	58	1.14	0.046	100	13	19	34	ND
308	9.5	285/310	545/590	38	100	32.5	24	0.41	0.016	90	NU	19	33	53
✓309	9.2	285/310	545/590	160	320	78.5	58	1.22	0.048	100	13	19	33	U
✓310	9.2	285/310	545/590	177	350	81.5	60	1.17	0.046	100	10	19	33	ND
✓311	9.5	285/310	545/590	288	550	84	62	1.27	0.050	100	7	19	33	ND
315	14.6	280/295	540/560	A								21	37	ND
316	11.9	280/295	540/560	A								20	35	ND
✓317	10.7	280/295	540/560	177	350	78.5	58	1.24	0.049	100	13	19	34	ND
✓318	10.7	280/295	540/560	288	550	76	56	1.14	0.045	100	16	19	34	ND
319	11.9	280/295	540/560	A								20	35	ND
320	14.6	280/295	540/560	A								21	37	ND
355	7.6	295/310	565/590	104	220	76	56	1.27	0.050	100	NU	18	32	0
356	7.0	295/310	565/590	232	450	80	59	1.37	0.054	100	11	17.5	31	0
357	8.7	295/310	565/590	38	100	49	36	0.69	0.027	100	NU	18.5	33	44
358	8.0	295/310	565/590	66	150	70.5	52	1.02	0.040	100	NU	18	32	0
359	7.5	295/310	565/590	160	320	84	62	1.35	0.053	100	7	18	32	0
360	6.8	295/310	565/590	66	150	70.5	52	1.07	0.042	NA	NU	17	31	16
✓361	8.9	295/310	565/590	177	350	85.5	63	1.42	0.056	100	5	18.5	33	ND
362	8.3	295/310	565/590	A								18	32	ND
363	7.7	295/310	565/590	A								18	32	ND
364	6.8	295/310	565/590	A								17	31	ND
✓365	8.7	295/310	565/590	288	550	84	62	1.30	0.051	100	7	18	33	ND
366	8.0	295/310	565/590	A								18	32	ND
367	7.4	295/310	565/590	A								17.5	32	ND
											Average Upper Shelf Energy[h] After Irradiation = 81.5 J (59.9 ft/lb)			

[a]Only test data from specimens irradiated within the temperature range 280–310°C (540–590°F) were selected for determining the effect of irradiation on upper shelf energy.

[b]Average Cu content reported by Babcock and Wilcox Company – 0.19%.

[c]Total Fluence is sum of dose in forward and reverse positions of the capsule during irradiation.

[d]Temperature range includes the irradiation temperature in both forward and reverse positions of the capsule.

[e]A means specimens are available – they have not been tested.

[f]Predicted loss of Charpy V notch upper shelf energy from Regulatory Guide 1.99 (Revision 1 April 1977) – 0.05% Cu (lower bound) and Cu content of weld metal 62 W.

[g]Fast drop in load is determined from instrumented Charpy V notch test. A zero percent drop corresponds with onset of upper shelf. ND = not determined.

[h]Charpy V notch impact tests made at 160–288°C (320–550°F) used to determine average upper shelf energy values, NU results not used in calculation.

Table 3. Effect of Irradiation[a] on the Loss of Upper Shelf Charpy V Notch Impact Toughness for 63 W Weld Metal[b]

Specimen Number	Irradiation: Total Fluence[c] (10^{-18} n/cm^2)	Irradiation: Temperature Range[d] °C	Irradiation: Temperature Range[d] °F	Test Temperature[e] °C	Test Temperature[e] °F	Fracture Energy J	Fracture Energy ft/lb	Lateral Expansion mm	Lateral Expansion in.	Fracture Appearance % Ductile	Loss of Upper Shelf Energy, %: Actual	Loss of Upper Shelf Energy, %: Predicted[f] 0.05%	Loss of Upper Shelf Energy, %: Predicted[f] 0.30%	Fast Drop in Load[g] %
63 W-284	0			27	80	68	50	1.09	0.043	65				34
285	0			71	160	89	65.5	1.57	0.062	95				0
286	0			160	320	86.5	63.5	1.68	0.066	100				0
287	0			4	40	53	39	0.86	0.034	40				68
288	0			−46	−50	33.5	24.5	0.43	0.017	20				96
289	0			−18	0	45	33	0.64	0.025	35				81
290	0			52	125	81	59.5	1.32	0.052	95				0
291	0			99	210	89	65.5	1.57	0.062	100				0
292	0			135	275	86.5	63.5	1.55	0.061	100				0
293	0			232	450	92	67.5	1.63	0.064	100				0
											Average Upper Shelf Energy = 88 J (65 ft/lb)			
✔252	13.9	280/300	540/570	177	350	65.5	48	1.17	0.046	100	26.2	20.5	45	ND
✔253	11.3	280/300	540/570	288	550	69.5	51	1.07	0.042	100	21.5	19.5	44	ND
✔254	10.2	280/300	540/570	177	350	69.5	51	1.14	0.045	100	21.5	19	43	ND
✔255	10.2	280/300	540/570	288	550	68	50	1.09	0.043	100	23.1	19	43	ND
✔256	11.3	280/300	540/570	135	275	62.5	46	0.99	0.039	100	NU	19.5	44	ND
✔257	13.9	280/300	540/570	288	550	65.5	48	0.99	0.039	100	26.2	20.5	45	ND
258	8.7	275/295	525/560	82	180	36.5	27	0.41	0.016	100	NU	18	42	60
259	7.1	275/295	525/560	232	450	68	50	0.97	0.038	75		17	40	0
260	6.4	285/295	545/565	A								17	40	
261	6.4	285/295	545/565	A								17	40	
262	7.1	270/295	520/560	107	225	57	42	0.79	0.031	100	NU	17.5	40	11
✔263	8.7	270/295	520/560	177	350	66.5	49	1.07	0.042	100	24.6	18	42	0
											Average Upper Shelf Energy[h] After Irradiation = 67.5 J (49.6 ft/lb)			

[a]Only test data from specimens irradiated within the temperature range 270–300°C (520–570°F) were selected for determining the effect of irradiation on upper shelf energy.

[b]Average Cu content reported by Babcock and Wilcox – 0.30%.

[c]Total Fluence is sum of dose in forward and reverse positions of the capsule during irradiation.

[d]Temperature range includes the irradiation temperature in both forward and reverse positions of the capsule.

[e]A means specimens are available – they have not been tested.

[f]Predicted loss of Charpy V notch upper shelf energy from Regulatory Guide 1.99 (Revision 1 April 1977) – 0.05% Cu (lower bound) and Cu content of weld metal 63 W.

[g]Fast drop in load is determined from instrumented Charpy V notch test. A zero percent drop corresponds with onset of upper shelf. ND = not determined.

[h]Charpy V notch impact tests made at 177 to 288 °C (300 to 550°F) used to determine average upper shelf energy values. NU results not used in calculation.