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JOHN D. SIEBER
Vice President - Nuclear Group

July 8, 1992

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Beaver Valley Power Station, Unit No. 1 and No. 2
BV-1 Docket No. 50-334, License No. DPR-66
BV-2 Docket No. 50-412, License No. NPF-73
Response To Generic Letter 92-01

Enclosed are the following two reports which provide the information requested by Generic Letter 92-01:

1. Beaver Valley Unit 1, Response To Generic Letter 92-01, Reactor Vessel Structural Integrity, 10 CFR 50.54(f)

2. Beaver Valley Unit 2, Response To Generic Letter 92-01, Reactor Vessel Structural Integrity, 10 CFR 50.54(f)

We understand this information is required for NRC verification of our compliance with our current licensing basis regarding reactor vessel fracture toughness and material surveillance for the reactor coolant pressure boundary.

Sincerely,

J. D. Sieber

cc: Mr. L. W. Rossbach, Sr. Resident Inspector
Mr. T. T. Martin, NRC Region I Administrator
Mr. A. W. DeAgazio, Project Manager
Mr. M. L. Bowling (VEPCO)

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1/1

COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF BEAVER)

On this 8th day of July, 1992, before me, Sheila M. Fattore, a Notary Public in and for said Commonwealth and County, personally appeared J. D. Sieber, who being duly sworn, deposed, and said that (1) he is Vice President - Nuclear of Duquesne Light, (2) he is duly authorized to execute and file the foregoing Submittal on behalf of said Company, and (3) the statements set forth in the Submittal are true and correct to the best of his knowledge, information and belief.

Sheila M Fattore

Notarial Seal
Sheila M. Fattore, Notary Public
Shippingport Boro, Beaver County
My Commission Expires Sept. 26, 1994
Member, Pennsylvania Association of Notaries

BEAVER VALLEY UNIT 1

RESPONSE TO GENERIC LETTER 92-01

REACTOR VESSEL STRUCTURAL INTEGRITY, 10 CFR 50.54(f)

WP1331:1D/062392

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1.0 INTRODUCTION

On 6 March 1992 the U.S. Nuclear Regulatory Commission (NRC) issued Revision 1 of Generic Letter (GL) 92-01 to obtain information needed to assess compliance with the requirements and commitments regarding reactor vessel structural integrity. Section 50.60(a) of Title 10 of the Code of Federal Regulations (10 CFR 50.60(a)) requires that all light water nuclear power reactors, licensed by the NRC, meet fracture toughness requirements and have a material surveillance program for the reactor pressure boundary. These requirements are set forth in Appendices G and H to 10 CFR Part 50. If the requirements of Appendices G and H cannot be met, an exemption pursuant to 10 CFR 50.12 is required. 10 CFR 50.61 provides fracture toughness requirements for protecting pressurized water reactors against pressurized thermal shock events.

On a related topic, the U.S. Nuclear Regulatory Commission on 12-July-88 issued Generic Letter 88-11, "NRC Position on Radiation Embrittlement of Reactor Vessel Materials and its Impact on Plant Operations". The purpose of this generic letter was to call attention to Revision 2 of Regulatory Guide 1.99, "Radiation Embrittlement of Reactor Vessel Materials".

Each licensee was required to submit the results of a technical analysis relative to the implementation of this regulation. This submittal addressed the following:

1) Recalculation of adjusted reference temperature values at the 1/4 and 3/4 reactor vessel wall thickness locations for all potentially limiting materials using Regulatory Guide 1.99 Revision 2.

2) Determine the date of applicability of the P/T limits using Regulatory Guide Revision 2.

3) If the use of the Revision 2 methodology resulted in a modification of the P/T limits contained in the Technical Specification, a proposed schedule was required to be submitted that defined whatever action needed to be taken, including those required to address an expected restriction in operating flexibility.

Per GL 92-01, "This generic letter is part of a program to evaluate reactor vessel integrity and take regulatory actions, if needed, to ensure that licensees and permit holders are complying with the requirements of 10 CFR 50.60 and 10 CFR 50.61, and are fulfilling commitments made in response to GL 88-11."

This report describes the methods used and the results obtained in evaluating Beaver Valley Unit 1 relative to GL 92-01.

2.0 REACTOR VESSEL STRUCTURAL INTEGRITY REQUIRED INFORMATION

Question 1: Compliance with Appendix H to 10 CFR 50:

Determine if the Reactor Vessel Irradiation Surveillance Program is in compliance with Appendix H to 10 CFR 50 by determining which version of ASTM E-185 was used to develop the Reactor Vessel Irradiation Surveillance Program. If the program does not meet ASTM E-185-73, -79, or -82 and is not part of an approved "integrated surveillance program", describe the actions that have or will be taken to ensure that the Reactor Vessel Irradiation Surveillance Program complies with Appendix H to 10 CFR 50.

Response:

The Beaver Valley Unit 1 vessel was designed to the Winter 1968 Addenda to Section III of the ASME Code. ASTM E185-73 was the standard in place at the time the surveillance program was designed. The Beaver Valley Unit 1 surveillance program complies with ASTM E185-73. Testing of surveillance capsules after July 26, 1983 has been performed in accordance with ASTM

Standard version E185-82. Furthermore, the surveillance program design was approved during the FSAR licensing process and the present capsule testing program has been approved as part of the UFSAR. Therefore, it is determined that the surveillance program for Beaver Valley Unit 1 meets the requirements of Appendix H to 10 CFR Part 50 and that an exemption request is not considered necessary.

Question 2: Compliance with Appendix G to 10 CFR 50:

Question 2a: Calculate the Charpy Upper Shelf Energy (USE) for all of the beltline materials of the Beaver Valley Unit 1 reactor vessel using the methods of Regulatory Guide 1.99, Revision 2 for December 16, 1991 and for the end of the current license. If the calculated USE of the limiting beltline weld or plate of the Beaver Valley Unit 1 reactor vessel is below 50 ft-lbs, describe the actions that have or will be taken pursuant to Paragraphs IV.A.1 or V.C of Appendix G to 10 CFR Part 50 to address this issue.

Response:

Table 1 contains the December 16, 1991 and EOL Charpy upper shelf energy for Beaver Valley Unit 1 beltline materials. The calculated EOL Charpy upper shelf energy for all the beltline materials are predicted to be above the 50 ft-lb criteria.

Table 1

Beaver Valley Unit 1
Calculated Upper-Shelf Energy (USE) Values

Beltline Material	Initial USE (ft-lb)	12/16/91 USE (ft-lbs)	1/4T EOL(c) Fluence ($x10^{19}$ n/cm^2)	EOL USE (ft-lbs)
Intermediate Shell Plate, B6607-1	90	71.1	2.16	59.9
Intermediate Shell Plate, B6607-2	82.6	65.2	2.16	65.3
Lower Shell Plate, B7203-2	83.5	66	2.16	60.5
Lower Shell Plate, B6903-1	80.0	58.4	2.16	52
Intermediate Shell Longitudinal Weld Seam, Heat 305424	112(a)	80.6	0.49	69
Lower Shell Longitudinal Weld Seam, Heat 305414	(b)	--	--	--
Intermediate to Lower Shell Circumferential Weld, Heat 90136	(b)	--	--	--

(a) Based on surveillance weld.
(b) Initial Upper Shelf Energy values are not available.
(c) Fluence projections based on recent change in core design incorporating L_4P.

Question 2b: If the Beaver Valley Unit 1 reactor vessel was constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition, provide the following information:

a) All Charpy and drop weight test results for all unirradiated beltline materials, the unirradiated reference temperatures for each beltline material, and a description of the methods used for calculating these values

b) A description of the heat treatment performed on all beltline and surveillance material.

c) The heat numbers for each beltline plate or forging and the weld and flux lot number used to fabricate each beltline material and surveillance material and weld.

d) A description of the chemical composition of each beltline and surveillance material.

e) The heat number of the wire used for determining the weld chemical composition.

Response:

The Beaver Valley Unit 1 reactor vessel was constructed to Section III of the ASME Code, 1968 Edition with Addenda through Winter 1968. Thus, the Beaver Valley Unit 1 reactor vessel was constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition. Tables 2 through 16 document the unirradiated data (Charpy and drop weight test results, reference temperature, upper shelf energy, heat treatment, heat numbers, flux lot number and chemical composition) for all beltline region and surveillance materials. These values were developed using the current reactor pressure vessel material test requirements and acceptance standards at the time of fabrication.

Table 2

Beaver Valley Unit 1
Materials Certification Information

Component: Intermediate Shell, B6607-1,
Material Specification A533 Cl 1

Heat No.: C4381-1

MILL Chemical Analysis[1]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.23	1.40	0.015	0.016	0.25	0.62	0.55	0.14	--	0.010

Charpy Impact and Fracture Tests - Transverse[2]

Temp °F	Ft-Lbs	% Shear	Lat. Exp (inches)
-40	14.5	10	8
-40	16	10	9
-40	13	10	6
0	19	10	12
0	22	15	14
0	23.5	15	15
50	32.5	30	27
50	35	30	28
50	44	34	32
110	57	60	44
110	62.5	65	50
110	66	65	52
RT	58	50	42
RT	44	40	36
RT	40	40	33
160	80	85	63
160	90	100	71
160	95	100	76
210	91	100	63
210	87	100	71
210	95	100	75

Temp. °F	Drop Weights	NDT	RTNDT	USE
0	NF	10°F	43°F	90 ft-lb
0	NF			
-10	F			
-10	F			

Heat Treatment[1]

1600-1650°F, 9 hours. Brine quenched.
1200-1225°F, 9 hours. Brine quenched.
1100-1150°F, 60 hours. Furnace cooled.

Table 3

Beaver Valley Unit 1
Materials Certification Information

Component: Intermediate Shell, B6607-2
Material Specification A533 Cl 1

Heat No.: C4381-2

MILL Chemical Analysis[3]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.23	1.40	0.015	0.016	0.25	0.62	0.55	0.14	-	0.010

Charpy Impact and Fracture Tests - Transverse[4]

Temp °F	Ft-Lbs	% Shear	Lat. Exp. (mils)
-40	13.5	10	6
-40	15.5	10	8
-40	18	10	10
0	30	20	20
0	19	15	11
0	17	15	12
50	26.5	30	18
50	27	30	22
50	29	30	22
110	49	50	40
110	44	50	38
110	52	50	42
160	71	85	57
160	60	85	52
160	76	90	63
210	81	100	65
210	86	100	70
210	81	100	65

Temp. °F	Drop Weights	NDT	RTNDT	USE
-10	2,F	-10°F	73°F	82.6 ft-lb
-20	F			
0	NF			
0	NF			

Heat Treatment[3]

1600-1650°F, 9 hours. Brine quench.
1200-1225°F, 9 hours. Brine quench.
1100-1150°F, 60 hours. Furnace cooled.

Table 4

Beaver Valley Unit 1
Materials Certification Information

Component: Lower Shell, B7203-2 Heat No.: C6293-2
Material Specification A533 Cl 1

MILL Chemical Analysis[5]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.19	1.30	0.015	0.015	0.18	0.57	0.59	0.14	0.026	0.021

Charpy Impact and Fracture Tests - Transverse[6]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
-40	26	10	17
-40	13	10	9
-40	12	10	6
0	27	30	23
0	20	30	16
0	19	30	17
40	34	35	30
40	37	35	32
40	54	40	42
110	79	75	64
110	66.5	70	54
110	72.5	80	58
160	86.5	100	71
160	81.5	100	67
160	86	100	67
210	91	100	72
210	75	100	62
210	81	100	67

Temp. °F	Drop Weights	NDT	RTNDT	USE
-20	F	-20°F	20°F	83.5 ft-lb
-10	2 NF			
0	NF			

Heat Treatment[5]

1550-1650°F, 4 hours. Water quenched.
1200°F - 1250°F, 4 hours. Air cooled.
1125°F - 1175°F, 40 hours. Furnace cooled.

Table 5

Beaver Valley Unit 1
Materials Certification Information

Component: Lower Shell, B6903-1 Heat No.: C6317-1
Material Specification A533 Cl 1

MILL Chemical Analysis[7]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.20	1.31	0.010	0.015	0.18	0.54	0.55	0.20	0.028	0.014

Charpy Impact and Fracture Tests - Transverse[8]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
-100	4.0	3	4
-100	2.5	3	2
-100	4.5	3	0
-50	6.0	3	2
-50	11.0	5	7
-50	11.0	5	5
10	40.0	29	31
10	20.0	21	2[illegible]
10	28.5	18	1[illegible]
40	33.0	28	30
40	46.5	33	37
40	34.0	28	29
110	63.5	51	54
110	64.0	53	60
110	77.0	57	63
160	76.0	100	60
160	82.0	100	67
160	82.5	100	69
210	83.0	100	70
210	82.5	100	66
210	82.0	100	69

Temp. °F	Drop Weights	NDT	RTNDT	USE
-60	F	-50°F	27°F	80 ft-lb
-50	F			
-40	2 NF			
-20	NF			
0	NF			

Heat Treatment[7]

1550°F-1250°F, 4 hours. Water quenched.
1200°F ± 1250°F, 4 hours. Air cooled.
1125°F ± 1175°F, 40 hours. Furnace cooled.

Table 6

Beaver Valley Unit 1
Materials Certification Information

Component: Intermediate Shell Seams 19-714 A&B Heat No.: 305424,
Flux Linde 1092,
Flux Lot 388
B4 Mod.

MILL Chemical Analysis[9]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.13	1.46	0.013	0.010	0.18	0.64	0.52	0.30	--	--

Charpy Impact and Fracture Tests[9]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
10	82		
10	87		
10	92		

Temp. °F	Drop Weights	NDT	RTNDT	USE
			*-56°F	

Post Weld Heat Treatment[9]

1125-1175°F, 40 hours, Furnace cooled.

* Estimated per NRC Regulatory Review Plan MTEB 5-2

Table 7

Beaver Valley Unit 1
Materials Certification Information

Component: Intermediate Shell to Lower Shell Seam 11-714

Heat No.: 90136,
Flux Linde 0091,
Flux Lot 3977
B4

MILL Chemical Analysis[9]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.11	1.17	0.013	0.010	0.17	--	0.49	0.30	--	--

Charpy Impact and Fracture Tests[9]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
10 10 10	100 112 108		

Temp. °F	Drop Weights	NDT	RTNDT	USE
			*-56°F	

Post Weld Heat Treatment[9]

1125-1175°F, 40 hours, Furnace cooled.

* Estimated per NRC Regulatory Review Plan MTEB 5-2

Table 8

Beaver Valley Unit 1
Materials Certification Information

The following information was taken from the Weld Inspection Report prepared by Combustion Engineering, Inc. in March 1970.

Component: Lower Shell Seams 20-714 A&B

Heat No.: 305414,
Flux Linde 1092,
Flux Lot 394.7
B4 Mod.

MILL Chemical Analysis[10]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.14	1.45	0.012	0.010	0.18	0.59	0.51	0.33	--	--

Charpy Impact and Fracture Tests[10]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
10	82		
10	66		
10	80		

Temp. °F	Drop Weights	NDT	RTNDT	USE
			*-56°F	

Post Weld Heat Treatment[10]

1125-1175°F, 40 hours, Furnace cooled.

* Estimated per NRC Regulatory Review Plan MTEB 5-2

Table 9

Beaver Valley Unit 1
Materials Certification Information

Component: Intermediate Shell to Lower Shell Seam 11-714

Heat No.: 90136,
Flux Linde 0091,
Flux Lot 3998
B4

MILL Chemical Analysis[11]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.11	1.16	0.013	0.010	0.16	--	0.50	0.37	--	--

Charpy Impact and Fracture Tests[11]

Temp °F	Ft-Lbs	% Shear	Mils Lat. Exp.
10 10 10	110 116 107		

Temp. °F	Drop Weights	NDT	RTNDT	USE
			*-56°F	

Post Weld Heat Treatment[11]

1125-1175°F, 40 hours, Furnace cooled.

* Estimated per NRC Regulatory Review Plan MTEB 5-2

Table 10

Beaver Valley Unit 1
Materials Certification Information

Component: Surveillance Plate (Vessel Lower Shell), B6903-1

Heat No.: C6317-1

MILL Chemical Analysis[12]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.20	1.31	0.010	0.015	0.180	0.54	0.55	0.20	0.028	0.014

Charpy Impact and Fracture Tests - Transverse[12]

Temp °F	Ft-Lbs	% Shear	Lat. Exp. (inches)
-100	4.0	3	4
-100	2.5	3	2
-100	4.5	3	0
-100	5.0	3	0
-50	11.0	9	6
-50	6.0	3	2
-50	11.0	5	7
-50	11.0	5	5
-50	13.5	5	7
10	28.5	23	23
10	40.0	29	31
10	20.0	21	26
10	28.5	18	19
10	33.0	27	2[illegible]
40	31.0	27	27
40	33.0	28	30
40	46.5	33	37
40	34.0	28	29
40	41.0	33	33
40	36	31	32
110	65.0	51	55
110	63.5	51	54
110	64.0	53	60
110	77.0	57	63
160	76.5	100	67
160	76.0	100	60
160	82.0	100	67
160	82.5	100	69
160	79.5	100	67

Temp °F	Ft-Lbs	% Shear	Lat. Exp. (inches)
210	83.0	100	80
210	82.5	100	66
210	62.0	100	69
210	75.0	100	65

Temp. °F	Drop Weights	NDT	RTNDT	USE
		-50°F	27°F	80 ft-lb

Heat Treatment[12]

1150-1650°F, 4 hours, Water quenched.
1200-1250°F, 4 hours, Air cooled.
1125-1175°F ± 25°F, 40 hours, Furnace cooled.

Table 11

Beaver Valley Unit 1
Materials Certification Information

Component: Surveillance Weldment

Heat No.: 305424,
Flux Linde 1092,
Flux 3889, B4 Mod.

MILL Chemical Analysis[12]

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co
0.110	1.370	0.018	0.006	.270	0.620	0.480	0.260	0.010	0.014

Charpy Impact and Fracture Tests[12]

Temp °F	Ft-Lbs	% Shear	Lat. Exp. (inches)
-150	4.0	50	0.0
-150	2.5	40	0.0
-150	2.0	25	0.0
-60	37.0	35	28.0
-60	27.0	35	22.0
-60	26.0	30	22.0
-25	88.0	85	68.0
-25	77.0	70	53.0
-25	75.0	70	59.0
0	80.0	75	57.0
0	66.5	50	47.0
0	88.0	75	60.0
100	100.0	95	78.0
100	108.5	99	81.0
100	117.5	100	88.5
210	110.0	100	84.0
210	103.5	100	82.0
210	122.0	100	93.0

Temp. °F	Drop Weights	NDT	RTNDT	USE
		-60°F	-60°F	112 ft-lb

Post Weld Heat Treatment[12]

1125-1175°F, 40 hours, furnace cooled.

Table 12

Beaver Valley Unit 1
Materials Certification Information

Component: Surveillance Weld Heat-Affected Zone Material

MILL Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu	Al	Co

Charpy Impact and Fracture Tests[12]

Temp °F	Ft-Lbs	% Shear	Lat. Exp. (inches)
-150	5.0	20	0.0
-150	4.5	35	0.0
-150	7.0	20	0.0
-40	50.0	35	29.0
-40	50.5	50	31.0
-40	44.5	50	25.0
0	102.0	70	69.0
0	75.0	60	49.0
0	85.0	65	55.0
20	90.0	75	58.0
20	91.0	70	61.0
20	96.0	80	66.0
100	129.0	100	72.5
100	111.0	100	76.0
100	100.0	100	64.0
210	114.0	100	86.0
210	138.5	100	76.0
210	131.5	100	76.0

Temp. °F	Drop Weights	NDT	RTNDT	USE
		-40°F	-40°F	128 ft-lb

The nil-ductility transition temperature (NDTT) is defined as the maximum temperature at which a standard drop weight specimen breaks when tested according to the provisions specified in ASTM E-208, "Standard Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels". The NDTT was determined for each material by dropweight tests (ASTM E-208) performed by Combustion Engineering.

The unirradiated RT_{NDT} of the beltline region materials was established from the drop weight NDTT tests and the Charpy V-notch tests, using the guidance provided in NUREG-0800, Branch Technical Position, MTEB 5-2, "Fracture Toughness Requirements", and subarticle NB-2300 of the ASME Boiler and Pressure Vessel Code, Section III. The specific criteria used for each of the Beaver Valley Unit 1 beltline plates and weldments are as follows:

- The NDTT temperature, as determined by drop weight tests (ASTM E-208) is the RT_{NDT} if, at 60°F above the NDTT, at least 50 ft-lbs of energy and 35 mils lateral expansion are obtained in Charpy V-notch tests on transverse specimens. Otherwise, the RT_{NDT} is the temperature at which 50 ft-lbs and 35 mils lateral expansion are obtained on transverse Charpy specimens, minus 60°F. These criteria were applied in determining the initial RT_{NDT} values for the surveillance plate and weldment.

- If drop weight tests were not performed, but full Charpy V-notch curves were obtained, the NDTT for SA-533 Grade B, Class 1 plate and weld material may be assumed to be the higher of the 30 ft-lb temperature, or 0°F. The Charpy V-notch data for intermediate shells, heats B6607-1 and B6607-2, and lower shells, heats B7203-2 and B6903-1 were from transverse specimens tested by Westinghouse. The initial RT_{NDT} values were the 30 ft-lb temperature from the full Charpy V-notch curves.

- If measured values of RT_{NDT} are not available, the generic mean values must be used: 0°F for welds made with Linde 80 flux, and -56°F for welds made with Linde 0091, 1092 and 124 and ARCOS B-5 weld fluxes, as per 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized

Thermal Shock Events". These criteria were used in establishing the initial RT_{NDT} values for the intermediate shell seams 19-714 A and B, intermediate shell to lower shell seams 1?-714, and lower shell seams 20-714 A and B.

The unirradiated upper shelf energy for the beltline region plates, and weldments were determined from Charpy V-notch tests using transverse specimen data. The upper shelf energy is the average of the transverse Charpy energy values for specimens exhibiting fully ductile behavior (i.e. 100% shear).

The surveillance material charpy and tensile specimens received heat treatments, including stress relieving operations, equivalent to those given to the actual reactor vessel materials as required by Section III of the ASME Boiler and Pressure Vessel Code. Combustion Engineering supplied Westinghouse Electric Corporation with sections of A533 Grade B, Class 1 plate used in the core region of the Beaver Valley Unit 1 reactor pressure vessel for use in the Reactor Vessel Radiation Surveillance Program. The sections of material were removed from the 7 7/8-inch lower shell course of the pressure vessel. Combustion Engineering, Inc., also supplied a weldment made from sections of the intermediate shell plates B6607-1 and B6607-2 using weld wire representative of that used in the original fabrication. The plates were produced by Lukens Steel Co. The heat treatment history of the pressure vessel beltline region material and surveillance materials are given in Tables 2 through 12.

Question 3: Generic Letter 88-11 Commitments:

Question 3a: How the embrittlement effects of operating at an irradiation temperature (cold leg or recirculation suction temperature) below 525 degrees F were considered. In particular licensees are requested to describe consideration given to determining the effect of lower irradiation temperature on the reference temperature and on the Charpy upper shelf energy.

Response:

Beaver Valley Unit 1 has not operated at temperatures below 525°F, and therefore, will have no impact on prediction of RT_{NDT} or upper shelf energy.

Question 3b: How the Beaver Valley Unit 1 surveillance results on the predicted amount of embrittlement were considered in GL 88-11.

Response: The Beaver Valley Unit 1 surveillance data are credible in all respects as judged by the criteria defined in Regulatory Guide 1.99, Revision 2 In the Beaver Valley Unit 1 generic letter 88-11 response, the surveillance results were considered in predicting the ΔRT_{NDT} and margin values and calculating chemistry factors required by Regulatory Guide 1.99 Revision. The current operating limits incorporate these values.

Question 3c: If a measured increase in reference temperature exceeds the mean-plus-two standard deviations predicted by Regulatory Guide 1.99, Revision 2, or if a measured decrease in upper shelf energy exceeds the value predicted using the guidance in Paragraph C.1.2 in Regulatory Guide 1.99, Revision 2, the licensee is requested to report the information and describe the effect of the surveillance results on the adjusted reference temperature and Charpy upper shelf energy for each beltline

material as predicted for December 16, 1991, and for the end of its current license.

Response:

Comparison of the Beaver Valley Unit 1 surveillance capsule data with predicted changes in the 30 ft-lb transition temperature and upper shelf energy using the methods of Regulatory Guide 1.99, Rev. 2 are provided in Table 13. The measured percent decease in upper shelf energy are less than that predicted by the Regulatory Guide. The measured transition temperature increase for plate B6903-1 have exceeded the mean-plus-two standard deviation bound predicted by Regulatory Guide 1.99, Revision 2. The adjusted reference temperature (ART) for each beltline material are provided in Table 14. The larger measured shift in RT_{NDT} for lower shell plate B6903-1 is accounted for by the use of this data in determining the current operating limits.

3.0 CONCLUSIONS

The following is a summary of the conclusions relative to GL 92-01:

- The Beaver Valley Unit 1 surveillance programs meets the requirements of Appendix H to 10 CFR Part 50.
- The Beaver Valley Unit 1 reactor vessel was constructed in accordance with the Winter 1968 Addenda of Section III of the ASME Code.
- The projected EOL upper shelf energy values for the Beaver Valley Unit 1 beltline materials are above the 50 ft-lbs criteria.
- Beaver Valley Unit 1 has not operated at temperatures below 525°F.

Table 13

Comparison of Beaver Valley Unit 1
Reactor Vessel Surveillance Capsule Charpy Impact Test Results
With Regulatory Guide 1.99 Revision 2 Predictions

Material	Capsule	ΔRT_{NDT} (30 ft-lb Increase) R.G. 1.99 Rev. 2 (°F)	R.G. Pred. + 2σ	Measured (°F)	Δ Use R.G. 1.99 Rev. 2 (%)	Measured (%)
Plate B6903-1 (longitudinal)	V	94	128	130	22	14.9
	U	125	159	120	26	26.1
	W	140	174	150	29	14.9
Plate B6903-1 (transverse)	V	94	128	140	22	6.2
	U	125	159	135	26	2.5
	W	140	174	185	29	26.2
Weld Metal	V	118	174	150	29	21.4
	U	158	214	155	35	25.9
	W	176	232	185	38	30.4
HAZ Metal	V	--	--	0	--	10.[illegible]
	U	--	--	35	--	18.0
	W	--	--	60	--	10.9

Table 14

Beaver Valley Unit 1 Adjusted Reference Temperature
Values for 12/16/91 and End-of-License (32 EFPY)

Beltline Material	CU (WT%)	NI (WT%)	CF	IRTNDT (°F)	Margin	12/16/91 ART (°F)	32 EFPY ART
Inter. shell, B6507-1	0.14	0.62	100.50	43	34	182	210
Inter. shell, B6607-2	0.14	0.62	100.50	73	34	212	240
Lower shell, B6903-1, using S/C data	0.20	0.54	141.80 167.81	27 27	34 17*	209 219	249 266
Lower shell, B7203-2	0.14	0.57	98.65	20	34	157	185
Long. weld, 305424 using S/C data	0.28	0.63	191.65 191.33	-56	66 44*	121 99	188 166
Long. weld, 305414	0.35	0.61	213.45	-56	66	134	206
Circumferential weld	0.29	0.07	132.90	-56	66	148	186

*Margin was reduced according to methodology, specified in Reg. Guide 1.99 Rev. 2 [2].

- The Beaver Valley Unit 1 surveillance data are credible in all respects as judged by the criteria defined in Regulatory Guide 1.99, Revision 2.

- The response to GL 88-11 considered the Beaver Valley Unit 1 surveillance results in predicting ΔRT_{NDT} and calculating chemistry factors used in RT_{PTS} calculations and current operating limits incorporate these results.

- The measured transition temperature increase for plate B6903-1 have exceeded the mean-plus-two standard deviation bound predicted by Regulatory Guide 1.99, Revision 2. The effect of this was taken into account when the PTS submittal and operating limits were generated.

4.0 REFERENCES

1. Material Certification Report, Babcock & Wilcox Company, January 5, 1971. (Plate B6607-1, heat C4381-1)

2. Westinghouse Laboratory Services EML No. A 1843, October 8, 1973.

3. Materials Certification Report, Babcock & Wilcox Company, January 5, 1971. (Plate B6607-2, heat C4381-2)

4. Westinghouse Laboratory Services, EML No. A 1844, October 8, 1973.

5. Material Certification report, Combustion Engineering, March 17, 1970, Job No. X-96253-001BS.

6. Westinghouse Laboratory Services, EML No. A 1845, October 8, 1973.

7. Materials Certification Report, Combustion Engineering, March 17, 1970, Job No. X-96253-003BS.

8. Westinghouse Laboratory Services, EML No. A 1019, March 29, 1972.

9. Weld Inspection Report, Combustion Engineering, February 1971.

10. Weld Inspection Report, Combustion Engineering, March 1970.

11. Weld Inspection Report, Combustion Engineering, March 1971.

12. WCAP-8457, "Duquesne Light Company Beaver Valley Unit 1 Reactor Vessel Radiation Surveillance Program Report, Westinghouse, October 1974.

BEAVER VALLEY UNIT 2

RESPONSE TO GENERIC LETTER 92-01
REACTOR VESSEL STRUCTURAL INTEGRITY, 10 CFR 50.54(f)

WP1334:1D/062392

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1.0 INTRODUCTION

On 6 March 1992 the U.S. Nuclear Regulatory Commission (NRC) issued Revision 1 of Generic Letter (GL) 92-01 to obtain information needed to assess compliance with the requirements and commitments regarding reactor vessel structural integrity. Section 50.60(a) of Title 10 of the Code of Federal Regulations (10 CFR 50.60(a)) requires that all light water nuclear power reactors, licensed by the NRC, meet fracture toughness requirements and have a material surveillance program for the reactor pressure boundary. These requirements are set forth in Appendices G and H to 10 CFR Part 50. If the requirements of Appendices G and H cannot be met, an exemption pursuant to 10 CFR 50.12 is required. 10 CFR 50.61 provides fracture toughness requirements for protecting pressurized water reactors against pressurized thermal shock events.

On a related topic, the U.S. Nuclear Regulatory Commission on 12-July-88 issued Generic Letter 88-11, "NRC Position on Radiation Embrittlement of Reactor Vessel Materials and its Impact on Plant Operations". The purpose of this generic letter was to call attention to Revision 2 of Regulatory Guide 1.99, "Radiation Embrittlement of Reactor Vessel Materials".

Each licensee was required to submit the results of a technical analysis relative to the implementation of this regulation. This submittal addressed the following:

1) Recalculation of adjusted reference temperature values at the 1/4 and 3/4 reactor vessel wall thickness locations for all potentially limiting materials using Regulatory Guide 1.99 Revision 2.

2) Determine the date of applicability of the P/T limits using Regulatory Guide Revision 2.

3) If the use of the Revision 2 methodology resulted in a modification of the P/T limits contained in the Technical Specification, a proposed schedule was required to be submitted that defined whatever action needed to be taken, including those required to address an expected restriction in operating flexibility.

Per GL 92-01, "This generic letter is part of a program to evaluate reactor vessel integrity and take regulatory actions, if needed, to ensure that licensees and permit holders are complying with the requirements of 10 CFR 50.60 and 10 CFR 50.61, and are fulfilling commitments made in response to GL 88-11."

This report describes the methods used and the results obtained in evaluating Beaver Valley Unit 2 relative to GL 92-01.

2.0 REACTOR VESSEL STRUCTURAL INTEGRITY REQUIRED INFORMATION

Question 1: Compliance with Appendix H to 10 CFR 50:

Determine if the Reactor Vessel Irradiation Surveillance Program is in compliance with Appendix H to 10 CFR 50 by determining which version of ASTM E-185 was used to develop the Reactor Vessel Irradiation Surveillance Program. If the program does not meet ASTM E-185-73, -79, or -82 and is not part of an approved "integrated surveillance program", describe the actions that have or will be taken to ensure that the Reactor Vessel Irradiation Surveillance Program complies with Appendix H to 10 CFR 50.

Response:

The Beaver Valley Unit 2 vessel was fabricated in accordance with the requirements of the ASME Code, 1971 Edition including Addenda through Summer 1972. ASTM E185-73 was the standard in place at the time the surveillance program was designed. The Beaver Valley Unit 2 surveillance program complies with ASTM E185-73. Testing of surveillance capsules after July 26, 1983 has

been performed in accordance with ASTM Standard version E185-82. Furthermore, since the surveillance program design was approved during the FSAR licensing process, the capsule testing program has been approved as part of the plant Technical Specifications. Therefore, it is determined that the surveillance program for Beaver Valley Unit 2 meets the requirements of Appendix H to 10 CFR Part 50 and that an exemption request is not considered necessary.

Question 2: Compliance with Appendix G to 10 CFR 50:

Question 2a: Calculate the Charpy Upper Shelf Energy (USE) for all of the beltline materials of the Beaver Valley Unit 2 reactor vessel using the methods of Regulatory Guide 1.99, Revision 2 for the end of the current license. If the calculated USE of the limiting beltline weld or plate of the Beaver Valley Unit 2 reactor vessel is below 50 ft-lbs, describe the actions that have or will be taken pursuant to Paragraphs IV.A.1 or V.C of Appendix G to 10 CFR Part 50 to address this issue.

Response:

All vessel beltline materials for Beaver Valley Unit 2 are characterized in Table 1 in terms of initial upper-shelf energies, copper chemistries, and anticipated fluence levels at the 1/4 thickness position in the vessel. The initial upper-shelf energy levels for the beltline materials were determined from the unirradiated Charpy specimen data. Average copper values were determined from available chemistry data. Sources of chemistry data included fabrication material certifications and weld qualifications, and surveillance capsule specimen evaluations. Also, available chemistry data from plants with the same heat of weld wire as Beaver Valley Unit 2 beltline region welds were factored into the calculated copper values. Fluence at the 1/4 thickness position in the vessel is computed using the formula:

$$\text{fluence}_{1/4\ T} = f_{surf}\ (e^{-0.24x})$$

where ϕ_{surf} is the calculated value of fluence at the inside surface of the vessel, and x is the distance in inches from the inside surface (ignoring cladding) to the 1/4 thickness depth of the vessel wall. The predicted percent decrease in upper-shelf energy as a function of copper content and fluence was established using Figure 2 from Regulatory Guide 1.99, Revision 2 [10]. For materials that are estimated to be low in upper shelf energy (i.e., less than 50 foot-pounds) using the above prediction method, alternative methods of determining upper-shelf energy drop may be considered when available. The calculated end-of-life upper shelf energy values (see Table 1) for the Beaver Valley Unit 2 beltline materials are above the 50 foot-pounds criteria.

Question 2b: If the Beaver Valley Unit 2 reactor vessel was constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition, provide the following information:

a) All Charpy and drop weight test results for all unirradiated beltline materials, the unirradiated reference temperatures for each beltline material, and a description of the methods used for calculating these values.

b) A description of the heat treatment performed on all beltline and surveillance material.

c) The heat numbers for each beltline plate or forging and the weld and flux lot number used to fabricate each beltline material and surveillance material and weld.

d) A description of the chemical composition of each beltline and surveillance material.

e) The heat number of the wire used for determining the weld chemical composition.

Table 1

Beaver Valley Unit 2
End-of-License (32 EFPY) Upper Shelf Energy (USE)

Beltline Material	Cu (Wt. %)	% Decrease	1/4T EOL(b) Fluence (x 10^{19} n/cm^2)	Initial USE (ft-lb)	EOL USE (ft-lb)
Intermediate Shell Plate, B9004-1	0.07	26	3.87	83	61.4
Intermediate Shell Plate, B9004-2	0.07	26	3.87	75.5	55.9
Lower Shell Plate, B9005-1	0.08	26	3.87	82	60.7
Lower Shell Plate, B9005-2	0.07	26	3.87	77.5	57.4
Longitudinal Weld Seams, Heat 83642	0.06(a)	22	1.16	144.5	112.7
Intermediate to Lower Shell Circumferential Weld, Heat 83642	0.06(a)	26	3.87	144.5	106.9

(a) All welds, including surveillance, fabricated from same heat of weld wire. Previously reported value from chemistry on surveillance weld. Value reported is average of vessel welds and surveillance weld chemistry data from Combustion Engineering records.

(b) Calculated from neutron exposure projections provided in Capsule U.[2]

Response:

The Beaver Valley Unit 2 reactor vessel was fabricated in accordance with the requirements of the ASME Boiler and Pressure Vessel Code 1971 Edition including Addenda through Summer 1972.

Question 3: Generic Letter 88-11 Commitments:

Question 3a: How the embrittlement effects of operating at an irradiation temperature (cold leg or recirculation suction temperature) below 525 degrees F were considered. In particular licensees are requested to describe consideration given to determining the effect of lower irradiation temperature on the reference temperature and on the Charpy upper shelf energy.

Response:

Beaver Valley Unit 2 has not operated at temperatures below 525°F, and therefore, will have no impact on prediction of RT_{NDT} or Upper Shelf Energy.

Question 3b: How the Beaver Valley Unit 2 surveillance results on the predicted amount of embrittlement were considered in GL 88-11.

Response:

The Beaver Valley Unit 2 surveillance data are credible in all respects as judged by the criteria defined in Regulatory Guide 1.99, Revision 2.[1] In the Beaver Valley Unit 2 Generic Letter 88-11, the single set of available surveillance results was not considered in predicting the ΔRT_{NDT} and calculating chemistry factors used in RT_{PTS} calculations.

Question 3c: If a measured increase in reference temperature exceeds the mean-plus-two standard deviations predicted by Regulatory Guide 1.99, Revision 2, or if a measured decrease in upper shelf

energy exceeds the value predicted using the guidance in Paragraph C.1.2 in Regulatory Guide 1.99, Revision 2, the licensee is requested to report the information and describe the effect of the surveillance results on the adjusted reference temperature and Charpy upper shelf energy for each beltline material as predicted for December 16, 1991, and for the end of its current license.

Response:

Comparison of the Beaver Valley Unit 2 surveillance capsule data with predicted changes in the 30 ft-lb transition temperature and upper shelf energy using the methods of Regulatory Guide 1.99, Rev. 2 are provided in Table 2. This measured percent decrease in upper shelf energy are less than that predicted by the Regulatory Guide. The measured transition temperature increase for plate B9004-2 are bounded by the mean-plus-two standard deviation defined by Regulatory Guide 1.99, Revision 2.

TABLE 2

COMPARISON OF BEAVER VALLEY UNIT 2
REACTOR VESSEL SURVEILLANCE CAPSULE CHARPY IMPACT TEST RESULTS
WITH REGULATORY GUIDE 1.99 REVISION 2 PREDICTIONS

Material	Capsule	ΔRT_{NDT} (30 ft-lb Increase)			Δ Use	
		R.G. 1.99 Rev. 2 (°F)	R.G. Pred. + 2σ	Measured (°F)	R.G. 1.99 Rev. 2 (%)	Measured (%)
Plate B9004-2 (longitudinal)	U	27	61	15	17	0
Plate B9004-2 (transverse)	U	27	61	30	17	0
Weld Metal	U	37	93	25	19	4

3.0 CONCLUSIONS

The following is a summary of the conclusions relative to GL 92-01:

- The Beaver Valley Unit 2 surveillance programs meets the requirements of Appendix H to 10 CFR Part 50.

- The Beaver Valley Unit 2 reactor vessel was constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code 1971 Edition including Addenda through Summer 1972.

- The projected end-of-life upper shelf energy values for the Beaver Valley Unit 2 beltline materials are above the 50 ft-lbs criteria.

- Beaver Valley Unit 2 has not operated at temperatures below 525°F.

- The Beaver Valley Unit 2 surveillance data are credible in all respects as judged by the criteria defined in Regulatory Guide 1.99, Revision 2.

- The response to GL 88-11 did not consider the Beaver Valley Unit 2 surveillance results in predicting ΔRT_{NDT} and calculating chemistry factors used in RT_{PTS} calculations.

- The measured transition temperature increase for plate B9004-2 are bounded by the mean-plus-two standard deviation defined in Regulatory Guide 1.99, Revision 2.

4.0 REFERENCES

1. Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," USNRC, May 1988.

2. S. E. Yanichko, et. al, "Analysis of Capsule U from the Duquesne Light Company Beaver Valley Unit 2 Reactor Vessel Radiation Surveillance Program," WCAP-12406, Westinghouse, September 1989.