NLR-N92081

ATTACHMENT 2

SALEM UNIT 2

RESPONSE TO GENERIC LETTER 92-01, REVISION 1

REACTOR VESSEL STRUCTURAL INTEGRITY

JUNE 17, 1992

REVISION 0

9207070035 920630
PDR ADOCK 05000272
P PDR

PSE&G has prepared the following information in response to the requests in Generic Letter 92-01, Revision 1 titled "REACTOR VESSEL STRUCTURAL INTEGRITY". In the following text, the individual requests for information are stated in boldface type as written in GL 92-01, and each request is followed by the PSE&G response in regular (non-boldface) type.

1. Certain addressees are requested to provide the following information regarding Appendix H to CFR Part 50:

Addressees who do not have a surveillance program meeting ASTM E 185-73, -79, or -82 and who do not have an integrated surveillance program approved by the NRC (see Enclosure 2), are requested to describe actions taken or to be taken to ensure compliance with Appendix H to 10 CFR Part 50. Addressees who plan to revise the surveillance program to meet Appendix II to 10 CFR Part 50 are requested to indicate when the revised program will be submitted to the NRC staff for review. If the surveillance program is not to be revised to meet Appendix H to 10 CFR Part 50, addressees are requested to indicate when they plan to request an exemption from Appendix H to 10 CFR Part 50 under 10 CFR 50.60(b).

Response:

ASTM E-185-73 was the standard in place at the time the surveillance program was designed. The Salem Unit 2 surveillance program complies with ASTM E-185-73. Testing of surveillance capsules after July 26, 1983 has been performed in accordance with ASTM Standard version E-185-82. 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 Salem Unit 2 meets the requirements of Appendix H to 10 CFR Part 50 and that an exemption request is not considered necessary.

2. Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:

a. Addressees of plants for which the Charpy upper shelf energy is predicted to be less than 50 foot-pounds at the end of their licenses using the guidance in Paragraphs C.1.2 or C.2.2 in Regulatory Guide 1.99, Revision 2, are requested to provide to the NRC the Charpy upper shelf energy predicted for December 16, 1991, and for the end of their current license for the

limiting beltline weld and the plate or forging and are requested to describe the actions taken pursuant to Paragraphs IV.A.1 or V.C of Appendix G to 10 CFR Part 50.

Response:

Table 1 contains the unirradiated, December 16, 1991 and EOL (April 18, 2020) Charpy upper shelf energy for Salem Unit 2 beltline materials. The December 16, 1991 and EOL values were calculated using Figure 2 of Regulatory Guide 1.99, Revision 2. The calculated EOL Charpy upper shelf energy for all the beltline materials which have known unirradiated USE values are predicted to be above the 50 ft-lb criteria.

b. Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph II.A of 10 CFR Part 50, Appendix G:

(1) The results from all Charpy and drop weight tests for all unirradiated beltline materials, the unirradiated reference temperature for each beltline material, and the method of determining the unirradiated reference temperature from the Charpy and drop weight test;

(2) The heat treatment received by all beltline and surveillance materials;

(3) The heat number for each beltline plate or forging and the heat number of wire and flux lot number used to fabricate each beltline weld;

(4) The heat number for each surveillance plate or forging and the heat number of wire and flux lot number used to fabricate the surveillance weld;

(5) The chemical composition, in particular the weight in percent of copper, nickel, phosphorous, and sulfur for each beltline and surveillance material; and

(6) The heat number of the wire used for determining the weld metal chemical composition if different than Item (3) above.

Response:

The Salem Unit 2 reactor vessel was constructed to the 1965 Edition, through Winter 1966 Addenda to Section III of the ASME Code. Thus, the Salem Unit 2 reactor vessel was constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition. Tables 2 through 14 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 material test requirements and acceptance standards that were current at the time of the reactor pressure vessel construction. (Note that the chemical composition of the welds was determined from the weld wire heat numbers of the actual welds, except for weld 9-442, in which the nickel content was estimated to be the upper limit of type MIL B-4 wire heats).

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 beltline region material by dropweight tests (ASTM E-208) performed by Combustion Engineering except for welds 3-442A, 3-442B, 3-443C and 9-442.

The unirradiated reference temperature (RTNDT) 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 the ASME Boiler and Pressure Vessel Code, Section III. The following three paragraphs summarize pertinent information from these two references, and the fourth following paragraph summarizes information from 10CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock."

> The NDTT temperature, as determined by drop weight tests (ASTM E-208) is the RTNDT 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 RTNDT is the temperature at which 50 ft-lbs and 35 mils lateral expansion are obtained on transverse Charpy specimens, minus 60°F.

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.

If transverse Charpy V-notch specimens were not tested, the temperature at which 50 ft-lbs and 35 mils lateral expansion would have been obtained on transverse specimens may be estimated by using 65% of the values from longitudinal specimens, or increasing the 50 ft-lbs and 35 mil lateral expansion temperatures for longitudinal specimens by 20°F.

If measured values of RTNDT 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 CFR50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events."

The Charpy V-notch data for each of the beltline region plates tested by Combustion Engineering were taken in the longitudinal direction. The RTNDT values for each of these materials were determined to be the higher of the (1) value obtained by increasing the temperature at which 50 ft-lbs and 35 mils lateral expansion were obtained for longitudinal specimens by 20°F (to estimate the temperature in the transverse direction for which 50 ft-lbs and 35 mils lateral expansion would have been obtained), reduced by 60°F or (2) the NDTT. The RTNDT values for the intermediate shell longitudinal weld seams 2-442A, B and C and the surveillance weld heat affected zone material were determined to be equal to their NDTT values. Full Charpy curves were not tested for lower shell longitudinal welds and the intermediate shell to lower shell circumferential weld seams; therefore, the generic mean value of -56°F is assumed. The transverse Charpy test data was used to determine the RTNDT for the surveillance test plate.

The unirradiated upper shelf energy may be determined from Charpy V-notch tests using transverse specimen data (or using longitudinal data multiplied by 65% to estimate transverse data). The upper shelf energy is the average of the transverse Charpy energy values for specimens exhibiting fully ductile behavior (i.e. 100% shear), at a given test temperature. Typically, specimens are tested in sets of three at each test temperature. The set having the highest average may be regarded as defining the upper shelf energy, as per ASTM E-185-82. The upper shelf energy values for the beltline region plates were calculated by multiplying the average of the 100% shear longitudinal Charpy V-notch data by 65%. The upper shelf energy value for the surveillance test plate was determined by taking the average of the three 100% shear energy values for the transverse data obtained in tests conducted by Westinghouse Electric Corporation.

The upper shelf energy values for the intermediate shell longitudinal weld and surveillance weld materials were determined by the average of the three 100% shear energy values. Upper shelf energy values were not calculated for the lower shell longitudinal welds and intermediate to lower shell circumferential welds because full Charpy V-notch curves were not generated for these materials.

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 Salem Unit 2 reactor pressure vessel for use in the Reactor Vessel Radiation Surveillance Program. The sections of material were removed from the 9 5/8-inch intermediate shell plate B4712-2 of the pressure vessel. Combustion Engineering, Inc., also supplied a weldment made from sections of the intermediate shell plate B4712-2 and adjoining intermediate shell plate B4712-1 using weld wire representative of that used in the original fabrication. The heat treatment histories of the pressure vessel beltline region material and surveillance materials are given in Tables 2 through 14.

3. Addressees are requested to provide the following information regarding commitments made to respond to GL 88-11:

a. How the embrittlement effects of operating at an irradiation temperature (cold leg or recirculation suction temperature) below 525°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:

The PSE&G Operations Department performed a review of its policies and procedures to determine if the stated scenario, i.e., cold leg temperature below 525°F while at power, has occurred for more than 24 hours total.

This review included Integrated Operating Procedure-3 "Hot Standby to Minimum Load", which states that Tave must be verified greater than 541°F within 15 minutes of achieving criticality. In addition, Technical Specification 3.1.1.4 requires that while in Mode 1 and 2, Tave must be greater than 541°F. This LCO requires the temperature to be restored within 15 minutes or be in Hot Standby within an additional 15 minutes.

Based on department procedural requirements, it can be concluded that the outlined scenario has not occurred in the past and will not occur in the future at Salem. While historically there have been instances during plant transient, where RCS temperature may have gone below 525°F, the cumulative excursion time has been much less than 24 hours.

Therefore, the effect of lower irradiation temperature on the reference temperature and Charpy upper shelf energy is negligible.

b. How their surveillance results on the predicted amount of embrittlement were considered.

Response:

As explained in the PSE&G response to Generic Letter 88-11, the surveillance capsule analyses were conducted using the methods described in Regulatory Guide 1.99 Revision 2 to predict the effects of neutron radiation on the reactor vessel materials. PSE&G has complied with its commitment to submit a License Change Request to include new heatup and cooldown curves. Approval for the revised curves was received in January 1990 through Amendment 86 for the Salem Unit 2 Technical Specifications.

c. 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 Charpy 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:

The measured increase in reference temperature does not exceed the mean-plus-two standard deviation predicted by Regulatory Guide 1.99 Revision 2 for any of the surveillance capsule materials as indicated in Table 15. The measured decrease in Charpy upper shelf energy exceeds the value predicted using methodology specified in Regulatory Guide 1.99 Revision 2 for the weld metal as indicated in Table 15. Therefore the adjusted reference temperature and Charpy upper shelf energy of each beltline material as predicted by surveillance results for December 16, 1991 and end of current license are provided in Tables 16 and 17.

TABLE 1

SALEM UNIT 2

UNIRRADIATED AND CALCULATED UPPER SHELF ENERGY (USE) VALUES

Material Description	USE, ft-lbs Unirradiated	USE, ft-lbs[1] December 16, 1991	EOL USE ft-lbs[2] April 18, 2020
Intermediate Shell Plate B4712-1	90.0[3]	76.5	71.1
Intermediate Shell Plate B4712-2	83.0[3]	69.7	64.7
Intermediate Shell Plate B4712-3	75.0[3]	64.5	60.8
Intermediate Shell Long. Weld 2-442A	111.0	86.6	76.6
Intermediate Shell Long. Weld 2-442B	111.0	83.3	73.3
Intermediate Shell Long. Weld 2-442C	111.0	83.3	73.3
Lower Shell Plate B4713-1	82.5[3]	70.1	66.0
Lower Shell Plate B4713-2	88.0[3]	74.8	70.4
Lower Shell Plate B4713-3	88.0[3]	74.8	70.4
Lower Shell Long. Weld 3-442A	NA	NA	NA
Lower Shell Long. Weld 3-442B	NA	NA	NA
Lower Shell Long. Weld 3-422C	NA	NA	NA
Intermediate to Lower Shell Girth Weld 9-442	NA	NA	NA

NA - Unirradiated upper shelf energy not available because tests were not performed. In these cases, the December 16, 1991 and EOL USE values were not calculated.

(1) December 16, 1991 USE values calculated at ¼T location, based on fluences in PSE&G letter SCI-92-0357, 6/11/92, J. Perrin to J. Chicots.

(2) EOL USE values calculated at 1/4T location, based on fluences from PSE&G letter SCI-92-0319, 5/14/92, J. Perrin to J. Chicots.

(3) Unirradiated USE values estimated from longitudinal data.

TABLE 2

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. on November 12, 1968. (Corrected copy dated April 23, 1970).

Component: Intermediate Shell Plate B4712-1 Heat No.: C-4173-1

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.21	1.33	.012	.016	.22	.56	.54	.13*

*Per Salem 2 Table 6 of Westinghouse letter PSE-77-5 to PSE&G of October 10, 1977.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-80	8	0	4
-80	6	0	2
-40	20	10	16
-40	22	10	18
-40	21	10	17
+10	51	25	38
+10	52	25	39
+10	57	25	43
+40	69	35	51
+40	79	35	59
+40	75	35	56
+110	105	85	74
+110	111	85	82
+160	140	100	88
+160	136	100	90

Temp., °F	Drop Weights	NDT	RTNDT	USE
+10	2NF	0°F	0°F	90 ft-lbs
0	1F			

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 3

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. on October 3, 1968. (Corrected copy dated April 23, 1970).

Components: Intermediate Shell Plate B4712-2 Heat No.: C-4186-2

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.22	1.37	.011	.015	.24	.60	.55	.14*

*Per Salem 2 Table 6 of Westinghouse letter PSE-77-5 to PSE&G of October 10, 1977.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-40	7	0	8
-40	12	0	9
-40	10	0	8
+10	21	10	20
+10	37	15	31
+10	30	15	26
+40	62	30	46
+40	49	25	39
+40	55	30	42
+110	96	70	69
+110	98	80	70
+110	90	70	67
+160	124	100	86
+160	134	100	92
+160	125	100	88

Temp., °F	Drop Weights	NDT	RTNDT	USE
0 -10 -20	1NF 2NF 1F	-20F	1°F	83 ft-lb

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 4

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from WCAP-8824, "PSE&G Co. Salem Unit No. 2 Reactor Vessel Radiation Surveillance Program," January 1977.

Component: B4712-2 Surveillance Material Heat No.: C-4186-2

Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.23	1.34	.015	.010	.30	.61	.55	.10

Transverse Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-40	12	10	5
-40	8	15	3
-40	12	10	7
0	34	25	26
0	34	25	27
0	24	18	18
+40	39	35	28
+40	36	34	28
+40	43	34	34
RT	58	52	46
RT	58	52	47
RT	61	52	49
+110	64	62	51
+110	74	68	61
+110	70	68	57
+210	100	100	80
+210	87	100	71
+210	104	100	75

Temp., °F	Drop Weights	NDT	RTNDT	USE
Performed by CE		-20°F	12°F	97 ft-lbs

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours. Air cooled.
1150°F ± 25°F, 40 hours. Furnace cooled.

TABLE 5

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering. Inc., on October 4, 1968. (Corrected copy dated April 23, 1970).

Component: Intermediate Shell Plate B4712-3 Heat No.: C-4194-2

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.22	1.37	.010	.016	.26	.57	.52	.11*

*Per Salem 2 Table 6 of Westinghouse letter PSE-77-5 to PSE&G of October 10, 1977.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-40	12	0	10
-40	11	0	9
-40	9	0	7
+10	33	20	26
+10	34	20	24
+10	28	20	23
+40	49	30	49
+40	50	30	49
+40	38	25	32
+110	100	85	75
+110	91	80	68
+110	79	75	60
+160	116	100	82
+160	122	100	84
+160	110	100	80

Temp., °F	Drop Weights	NDT	RTNDT	USE
0	1NF			
-20	1NF			
-40	2NF			
-50	1F	-50°F	22°F	75 ft-lbs
-60	1F			

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 6

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. on March 15, 1971 and "Salem Units 1 and 2 Reactor Vessel Weld Data," CE Inc., Design Input File T01.5-020, November 1985.

Component: Welds 2-442A, 2-442B, and 2-442C

Heat No.: 13253 & 20291 (tandem)

Flux: Linde 1092, Lot No. 3833

Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu	Cr
.12	1.29	.019	.012	.19	.73	.48	.23	.028

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-80	19	0	16
-80	26	10	21
-40	54	25	40
-40	39	20	31
+10	83	60	65
+10	94	70	72
+10	85	60	69
+40	83	70	63
+40	92	80	70
+40	97	80	76
+110	105	100	80
+110	108	100	84
+110	119	100	89
+160	113	100	87
+160	115	100	86

Temp. °F	Drop Weights	NDT	RTNDT	USE
-40	1F			
-30	2NF			
-20	1NF	-40°F	-40°F	111 ft-lbs
0	1NF			

Heat Treatment

1150°F for 12 hours.

TABLE 7

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering. Inc. on August 19, 1969.

Component: Lower Shell Plate B4713-1 Heat No.: C-4182-1

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.22	1.32	.010	.015	.22	.60	.54	.12*

* Per WCAP 10492, "Analysis of Capsule T from the Salem Unit 2 Reactor Vessel Radiation Surveillance Program," March 1984.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-80	9	0	6
-80	13	0	12
-40	25	10	21
-40	44	20	34
-40	16	5	12
+10	36	10	28
+10	65	30	46
+10	61	30	46
+40	60	30	47
+40	68	40	49
+40	64	35	48
+110	93	80	73
+110	108	85	75
+160	131	100	88
+160	123	100	88

Temp., °F	Drop Weights	NDT	RTNDT	USE
0	2NF			
-10	1F	-10°F	-10°F	82.5 ft-lbs
-20	1F			

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 8

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. on October 28, 1969.

Component: Lower Shell Plate B4713-2 Heat No.: C-4182-2

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.22	1.28	.010	.015	.24	.57	.53	.12*

* Per WCAP 10492, "Analysis of Capsule T from the Salem Unit 2 Reactor Vessel Radiation Surveillance Program," March 1984.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-80	6	0	3
-80	13	0	7
-40	43	20	31
-40	13	5	12
-40	22	10	16
+10	56	25	38
+10	42	20	31
+10	58	25	40
+40	79	35	58
+40	72	30	52
+40	89	40	63
+110	101	70	70
+110	112	80	78
+160	136	100	74
+160	135	100	76

Temp., °F	Drop Weights	NDT	RTNDT	USE
-20	1F			
-10	2NF			
0	1NF	-20°F	-20	88 ft-lbs

Heat Treatment

1550°F - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 9

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. on August 8, 1969.

Component: Lower Shell Plate, B4713-3 Heat No: B-8343-1

Mill Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.25	1.34	.012	.014	.28	.58	.53	.12*

* Per WCAP 10492, "Analysis of Capsule T from the Salem Unit 2 Reactor Vessel Radiation Surveillance Program," March 1984.

Longitudinal Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-40	19	0	10
-40	14	0	12
-40	12	0	10
+10	36	25	27
+10	52	30	37
+10	40	25	30
+40	63	35	46
+40	74	40	53
+40	50	30	38
+110	104	85	80
+110	108	90	82
+110	103	80	77
+160	135	100	85
+160	135	100	88
+160	136	100	91

Temp., °F	Drop Weights	NDT	RTDT	USE
-20	1F			
-10	1F			
0	2NF	-10°F	0°F	88 ft-lbs

Heat Treatment

1550 - 1650°F, 4 hours. Water quenched.
1225°F ± 25°F, 4 hours.
1150°F ± 25°F, 40 hours. Furnace cooled to 600°F.

TABLE 10

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from "Salem Units 1 and 2 Reactor Vessel Weld Data," CE Inc., Design Input File T01.5-020, November 1985 and CE Welding Material Qualification, October 27, 1969.

Component: Weld 3-442A, 3-442B, and 3-442C

Heat No.: 21935 and 12008 (tandem)

Flux: Linde 1092, Lot No. 3889

Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.11	1.38	.015	.011	.15	.86	.55	.20

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs
10	97
10	90
10	83

Full Charpy curve not performed.

Temp., °F	Drop Weights	NDT	RTNDT	USE
No drop wt. test performed.		---	-56°F (generic value per 10CFR 50.61)	---

Heat Treatment

1150°F for 8 hours.

TABLE 11

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from "Salem Units 1 and 2 Reactor Vessel Weld Data", CE Inc. Design Input File T01.5-020, November 1985 and CE Welding Material Qualification Report, October 7, 1970.

Component: Weld 9-442

Heat No.: 90099
Flux: Linde 0091, Lot No. 3977

Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu
.14	1.20	.021	.013	.22	.20*	.50	.175

*Estimated value.

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs
10	56
10	30
10	52

Full Charpy curve not performed.

Temp., °F	Drop Weights	NDT	RTNDT	USE
No drop wt. test performed.		---	-56°F (generic value per 10CFR 50.61)	---

Heat Treatment

1150°F for 10.5 hrs.

TABLE 12

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from "Salem Units 1 and 2 Reactor Vessel Weld Data" CE Inc., Design Input File T01.5-020, November 1985, and WCAP-8824, "PSE&G Co. Salem Unit No. 2 Reactor Vessel Radiation Surveillance Program," January 1979.

Component: Weld Surveillance Material
Weldment made from intermediate shell plates B4712-1 and B4712-2

Heat No.: 13253

Flux: Linde 1092, Lot No. 3833 and Linde 1092, Lot No. 3774

Chemical Analysis

C	Mn	P	S	Si	Ni	Mo	Cu	Cr
.10	1.27	.017	.011	.29	.71	.45	.23	.015

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-100	4.5	2	1
-100	11	6	2.5
-100	6	15	1
-50	11	18	7.5
-50	4	20	11
-50	35.5	29	27
0	48.5	52	42
0	72	52	36
0	63.5	62	50
40	71	59	56
40	50.5	55	44
40	80.5	79	62
100	86	100	81
100	96.5	90	74.5
100	106.5	100	80
210	112	98	82
210	111.5	100	86
210	111.5	100	85.5

Temp., °F	Drop Weights	NDT	RTNDT	USE
Performed by CE		-40°F	-20°F	111 ft-lbs

Heat Treatment

1150°F for 40 hours

TABLE 13

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the Materials Certification Report prepared by Combustion Engineering, Inc. March 15, 1971.

Component: Weld Heat Affected Zone
(Seam No. 2-442)

Chemical Analysis

Information not available (analyses were not performed)

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-110	15	0	12
-110	26	10	19
-80	41	20	31
-80	46	20	36
-40	45	30	38
-40	55	40	46
-40	47	30	39
+10	68	70	60
+10	87	80	76
+10	83	80	71
+40	105	95	86
+40	100	90	83
+40	104	95	80
+110	85	100	84
+110	104	100	98

Temp., °F	Drop Weights	NDT	RTNDT	USE
0 +10	1F 2NF	0°F	0°F	94.5 ft-lbs

Heat Treatment

1150°F ± 25°F, 40 hours.

TABLE 14

SALEM UNIT 2

MATERIALS CERTIFICATION INFORMATION

The following information was taken from the WCAP-8824, "PSE&G Co. Salem Unit No. 2 Reactor Vessel Radiation Surveillance Program January 1977."

Component: Weld Heat Affected Zone
Surveillance Material
(HAZ material obtained from
B4712-2 of weldment made from
intermediate shell plate
B4712-1 and B4712-2)

Chemical Analysis

Information not available (analyses were not performed on HAZ).

Charpy Impact and Fracture Tests

Temp., °F	Energy, ft-lbs	% Shear	Mils Lateral Exp.
-125	51	33	24.5
-125	23	6	15
-125	28	12	10.5
-75	122	100	63
-75	36	17	17
-75	66.5	42	34
-25	79	66	48
-25	93.5	48	47
-25	76	51	37
25	131	96	69
25	111	88	72
25	74	60	45
100	101	100	66.5
100	114	100	70
100	179	100	78.5
210	118.5	100	79.5
210	115	100	72.5
210	106.5	100	75

Temp., °F	Drop Weights	NDT	RTNDT	USE
Performed by CE		0°F	0°F	113 ft-lbs

Heat Treatment

1150°F for 40 hours.

TABLE 15

SALEM UNIT 2

MEASURED VERSUS PREDICTED 30 FT-LB TEMPERATURE INCREASES AND UPPER SHELF ENERGY DECREASES

Material	Capsule	Fluence (10^{19} n/cm^2)	ΔRTNDT (°F) (1,2)		Upper Shelf Energy (1) Decrease (%)	
			Measured	Predicted	Measured	Predicted
B4712-2 (long.)	T	0.276	50	99	6	14
B4712-2 (long.)	U	0.57	70	118	8	17
B4712-2 (long.)	X	1.16	80	138	1	20
B4712-2 (transverse)	T	0.276	70	99	8	14
B4712-2 (transverse)	U	0.57	95	118	13	17
B4712-2 (transverse)	X	1.16	125	138	8	20
Weld Metal	T	0.276	155	180	29(3)	27.5
Weld Metal	U	0.57	190	217	33(3)	32
Weld Metal	X	1.16	195	255	22	38

(1) Predicted values based on Regulatory Guide 1.99, Revision 2 Methodology.
(2) Predicted Δ RTNDT includes $2\sigma_\Delta$ as defined in Regulatory Guide 1.99, Revision 2.
(3) Exceeds predicted value.

TABLE 16

SALEM UNIT 2

ADJUSTED REFERENCE TEMPERATURES (ART) AS PREDICTED BY SURVEILLENCE DATA

Material Description	ART (°F) December 16, 1991	ART (°F) April 18, 2020	Screening Criterion
B4712-1	96.3[1] (96.3)[2]	131.9 (131.9)	270
B4712-2*	85.4 (96.4)	123.8 (134.8)	270
B4712-3	107.1 (95.1)	136.3 (124.3)	270
2-442A*	105.7	190.9	270
2-442B*	132.5	215.4	270
2-442C*	132.5	215.4	270
Weld Surveillance Material	(152.5)	(235.4)	270
B4713-1	81.7 (99.7)	115.3 (133.3)	270
B4713-2	71.3 (99.3)	104.6 (132.6)	270
B4713-3	91.4 (101.4)	124.9 (134.9)	270
3-442A	134.5	216.8	270
3-442B	108.5	190.0	270
3-442C	134.5	216.8	270
9-442	75.8	113.6	300

* ART based on surveillance capsule chemistry factor.
(1) Beltline plate, weld and HAZ material nos. are not in ().
(2) Surveillance material nos. are in ().

TABLE 17

SALEM UNIT 2

UPPER SHELF ENERGY (USE) AS PREDICTED BY SURVEILLANCE DATA

Material Description	USE (ft-lb) December 16, 1991	EOL USE (ft-lb) April 18, 2020
B4712-1	76.5[1] (89.3)[2]	71.1 (83.0)
B4712-2 (long.)*	(114.7)	(111.0)
B4712-2 (trans.)*	74.7 (87.3)	71.4 (83.4)
B4712-3	64.5 (92.0)	60.8 (86.7)
2-442A*	86.6	75.5
2-442B*	83.3	72.2
2-442C*	83.3	72.2
Weld Surveillance Material*	(83.3)	(72.2)
B4713-1	70.1 (83.3)	66.0 (78.4)
B4713-2	74.8 (87.6)	70.4 (82.4)
B4713-3	74.8 (103.7)	70.4 (97.6)
3-442A, B and C	NA[3]	NA
9-442	NA	NA
Weld HAZ*	72.8 (87.0)	63.3 (75.7)

* USE based on surveillance data trending on Figure 2 of Reg. Guide 1.99 Revision 2. All other USE predictions based on Cu content, using Figure 2 of Reg. Guide 1.99 Revision 2.

(1) Beltline plate, weld and HAZ material nos. not in ().
(2) Nos. in () are surveillance material.
(3) NA - Unirradiated upper shelf energy not available.