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SUBJECT: Forwards response to Rev 1 to Generic Ltr 92-01 re reactor vessel structural integrity.Charpy upper shelf energy projected not to drop below 50-ft pounds by end-of-life for facility.

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10CFR50.54(f)

R. B. STARKEY, JR.
Vice President
Nuclear Services Department

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
RESPONSE TO GENERIC LETTER 92-01, REVISION 1
REACTOR VESSEL STRUCTURAL INTEGRITY

Gentlemen:

The purpose of this letter is to provide Carolina Power & Light Company's (CP&L) response to NRC Generic Letter 92-01, "Reactor Vessel Structural Integrity," Revision 1. The Generic Letter, which was issued March 6, 1992, requests information needed to assess licensee compliance with requirements and commitments regarding reactor vessel integrity in view of concerns raised in the staff's review of reactor vessel integrity for the Yankee-Rowe Nuclear Power Station. Enclosure 1 provides CP&L's responses to the NRC requests for the H. B. Robinson Steam Electric Plant, Unit No. 2 (HBR2).

Please refer any questions regarding this submittal to Mr. R. W. Prunty at (919) 546-7318.

Yours very truly,

R. B. Starkey, Jr.

RES/jbw

Enclosure

cc: Mr. S. D. Ebneter
Mr. L. W. Garner
Ms. B. L. Mozafari

A028

R. B. Starkey, Jr., having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, contractors, and agents of Carolina Power & Light Company.

Eleanor C. Chappell
Notary (Seal)

ELEANOR C. CHAPPELL NOTARY PUBLIC WAKE COUNTY, N.C.

My commission expires: 2/6/96

(1685ARNP)

Enclosure 1

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
RESPONSE TO GENERIC LETTER 92-01, REVISION 1
REACTOR VESSEL STRUCTURAL INTEGRITY

NRC REQUEST:

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

> Addressees who do not have a surveillance program meeting ASTM E185-73, -79, or -82 and who do not have an integrated surveillance program approved by the NRC . . . are requested to describe actions taken or to be taken to ensure compliance with Appendix H to 10CFR Part 50. Addressees who plan to revise the surveillance program to meet Appendix H to 10CFR 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 10CFR Part 50, addressees are requested to indicate when they plan to request an exemption from Appendix H to 10CFR Part 50 under 10CFR50.60(b).

CP&L RESPONSE:

CP&L has a proposed Surveillance Program for HBR2 that meets the intent of ASTM E185-82 and thus complies with Appendix H to 10CFR Part 50. The original Surveillance Program for HBR2 was designed to satisfy ASTM E185-66. The number of capsules was more than sufficient to satisfy ASTM E185-82 as well; however, the fast neutron flux of four of the seven capsules lagged that of the vessel I.D. so much that they were useless for comparative or predictive purposes.

CP&L acted in 1982 to move two of the laggard capsules (U and X) to accelerated flux positions and remove accelerated Capsule T at an earlier time than called for by the surveillance schedule. These changes were made as part of a CP&L program to deal with the Pressurized Thermal Shock (PTS) question. It was essential at that time to obtain test results from the weld in Capsule T. The changes were described to NRC in a letter from E. E. Utley to H. R. Denton, December 7, 1982 (see Reference 9).

The accuracy of neutron flux mapping has improved significantly since 1970; lead factors are better known. CP&L took steps to achieve reductions in flux at the vessel wall (e.g., implementation of low leakage fuel loading pattern and installation of partial length shielding assemblies). Extension of license proposals are under consideration. Consequently, the capsule removal schedules prepared more than two decades ago will require correction. To this end, CP&L will be proposing by the start of Refueling Outage 15 (fall of 1993) to make small changes in the HBR2 schedule as reflected in the following table. Further, a license amendment request to move the schedule from the Technical Specifications to the FSAR as suggested by Generic Letter 91-01 is planned by December 15, 1992.

Capsule	Capsule Fluence[1, 2]	Max I.D. Fluence	Max ¼T Fluence	Calendar Years HBR2	Calendar Years Tech. Spec.	EFPY HBR2	EFPY ASTM E185-82
S[1]	4.3×10^{18}	2.3×10^{18}	1.3×10^{18}	3	3	1.3	1.5
V[1]	5.9×10^{18}	7.8×10^{18}	4.4×10^{18}	6	6	3.33	3
T	4.1×10^{19}	1.6×10^{19}	0.9×10^{19}	12	20	7.26	6
X	5.4×10^{19}	4.0×10^{19}	2.3×10^{19}	30	30	20	15
U[2]	6.7×10^{19}	5.0×10^{19}	2.9×10^{19}	40	40	27.4[2]	EOL

In this revised schedule, Capsule X, which contains both weld and base metal test specimens, would be removed at 30 calendar years in place of Capsule W or Y (They will be saved for extension-of-license purposes.). It will receive a fluence slightly greater than the vessel I.D. at end-of-license (EOL). Capsule U would be removed at 40 calendar years and will predict the I.D. fluence at approximately 52 calendar years.

NRC REQUEST:

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

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 10CFR50.61 and Paragraph III.A of 10CFR 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

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[1] Capsule fluences for Capsules S and V represent corrected values obtained from Westinghouse (W) in June 1992, per telecon between Mr. S. P. Grant (CP&L) and Mr. Stan Anderson (W).

[2] The fluences listed for Capsule U are given for the latest estimate of the achievable EFPYs within 40 calendar years which is 27.4 EFPY.

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.

CP&L RESPONSE:

Item a:

The Charpy upper shelf energy is projected not to drop below 50 ft. lb. by the EOL for HBR2. This projection is based on the actual data points obtained for Plate W10201-6 as shown in the attached Figure 1. The guidance in Paragraphs C.1.2 or C.2.2 in Regulatory Guide 1.99, Revision 2 was not used since actual data was available to project the EOL Charpy upper shelf energy.

HBR2 has measurements from surveillance capsules up to 4.1 x 10^{19} n/cm^2 (E > 1 MeV). In all cases, the upper shelf of the materials remains above 50 ft. lb.; they are reported in References 1-4. Capsule X is planned for removal after 30 calendar years or 5.4 x 10^{19} n/cm^2 (E > 1 MeV) which exceeds the maximum fluence projected for the reactor vessel at the end of license; therefore, its test results would predict the upper shelf behavior beyond EOL.

The core region plates were made from low nickel and copper steel with relatively low phosphorus, sulfur, and silicon as shown in the attached Table 1. The upper shelf energy of this steel is reduced only slightly by irradiation as shown in the attached Figure 1 and Table 2. The slope of the decrease is considerably less than that shown for Regulatory Guide 1.99, Revision 2; therefore, the actual slope for Plate W10201-6 is used for shelf projection for the other plates as shown in Table 2.

As previously stated, upon its removal after 30 calendar years, Capsule X will provide additional data on Plate W10201-4 and the surveillance weld metal for a fluence of 5.4 x 10^{19} n/cm^2 (E > 1 MeV).

Only a very small fraction of Plates W10201-1, 2, and 3 are exposed to the listed maximum fluence, whereas the gradient of neutron flux reduction with height above the core increases rapidly. A reduction also occurs circumferentially.

Item b:

(1) Preirradiated Charpy data, methods and NDTT are given in Reference 1 and Table A1 of Reference 2.

The Charpy curve for the surveillance weld is representative of the upper circumferential weld as well. The NRC generic initial RT_{NDT} is used for these welds.

Preirradiated Charpy and NDTT data for the lower circumferential weld (Heat 34B009 and Linde 1092 flux) are taken from measurements of the surveillance weld for Millstone 1 (Reference 5) which was made with the same materials. A full Charpy curve and drop weight results were obtained.

The preirradiated RT_{NDT} for the longitudinal welds is established by the NRC generic approach for Linde 1092 flux welds. Other data is found in WCAP-10433 for the Connecticut Yankee surveillance weld.

(2) Beltline plates were quenched and tempered. Welds were stress relieved in accordance with the requirements of the ASME Code Section III, 1965.

(3) The heat number for each beltline plate and weld wire heat number for each beltline weld joint is given in Reference 6. Flux lot numbers for the core region welds are supplied below:

WELD JOINT	FLUX TYPE	FLUX LOT
Upper Circ. Weld	Linde 1092	Lot 3617
Lower Circ. Weld	Linde 1092	Lot 3724
Longitudinal Welds	Arcos B5 (modified)	Lots 4D5F, 4E5F[3]

(4) The heat numbers for the surveillance plates and weld wire used to fabricate the surveillance weld are given in References 1 and 7. The weld flux was Linde 1092 (Lot 3617).

(5) Chemical compositions for beltline materials are given in References 6 and 7. Additional information on plates is given in Reference 1. Beltline plate material chemistries are summarized in the attached Table 1.

[3] Lots 4D5F and 4E5F are for the upper and middle shell course welds. The lot number for the lower shell is not available.

The lower circumferential weld is made from the same weld heat (Ht. No. 34B009) and flux (Linde 1092) as used for the Millstone 1 surveillance weld. The Millstone 1 surveillance weld chemistry is as follows:

C	Mn	P	S	Si	Mo	Ni *	Cu *
.11	1.34	.016	.016	.28	.49	1.03	.18

* Therefore, the Millstone surveillance weld chemistry has been adopted for use in establishing the HBR2 lower circumferential weld chemistry. Analyses for nickel and copper of the HBR2 head weld made with the same materials have also been factored into submittals to the NRC. Considering these head weld analyses with the above Millstone 1 surveillance weld chemistry, the HBR2 chemistry for the lower circumferential weld for nickel and copper is established to be 0.92 percent and 0.17 percent, respectively.

The chemistry of the longitudinal welds (Heat 86054B and Arcos B5 modified flux) in percent is taken from Connecticut Yankee Reports as follows:

C	Mn	P	S	Si	Mo	Ni	Cu
.100	1.38	.016	.017	.32	.51	.054	.22

(6) The heat numbers used for determining the chemical compositions of HBR2 beltline welds are the same as those referenced in item (3) above.

NRC REQUEST:

Addressees are requested to provide the following information regarding commitments made to respond to Generic Letter 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.

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

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.

CP&L RESPONSE:

Item a:

The HBR2 reactor system cold leg operated below 525°F during a three-year period from November 1981 to March 1984 for approximately 508 days. The reactor was at reduced power and fast neutron intensity because of steam generator tubing problems. The cold leg could have been as cold as 511°F during that period. The fluence accumulated in this time period was less than 2×10^{18} n/cm^2 (E > 1 MeV).

A predictive calculational approach to qualify the effect on fracture toughness is unavailable due to the shortage of operational or research data on the subject. Surveillance test results must be used to evaluate the effect of reactor system cold leg operation below 525°F.

HBR2 Surveillance Capsule T experienced only a few months of the reduced temperature operation before removal; however, its fast neutron exposure to 4.1×10^{19} n/cm^2 (E > 1 MeV) was well ahead of the HBR2 vessel exposure. The heatup and cooldown curves in current use are based on early maximum copper and nickel assumptions and are extremely conservative. New heatup and cooldown curves are now in preparation, using Capsule T results.

It is at this point that the proposed new surveillance capsule removal schedule becomes important. Capsule X, upon removal at 30 calendar years, will have experienced the full impact of the abnormal operation in 1981 through 1984; therefore, it can be used to predict the all-inclusive effects on fracture toughness beyond EOL for both weld and plate materials.

Item b:

Regulatory Guide 1.99, Revision 2, has been used for all materials. Section C2, "Surveillance Materials Available," has been used for the surveillance weld, whereas results from Capsule V and Capsule T were available in a straightforward manner. See Reference 8.

Item c:

HBR2 has found no such excessive variations in the results of surveillance tests.

References

1. H. B. Robinson Unit No. 2 Reactor Vessel Radiation Surveillance Program, WCAP-7373, S.E. Yanichko, January 1970.

2. Analysis of Capsule S from CP&L H. B. Robinson Unit No. 2 Reactor Vessel Radiation Surveillance Program, WCAP-8249, December 18, 1973.

3. Letter E. E. Utley to B. C. Rusche, H. B. Robinson Steam Electric Plant Unit No. 2 Reactor Vessel Material Surveillance Program, Analysis of Capsule V, December 7, 1976.

4. Analysis of Capsule T from the H. B. Robinson Unit 2 Reactor Vessel Radiation Surveillance Program, WCAP-10304, March 1983.

5. Fracture Toughness of Reactor Pressure Vessel Steel Welds, General Electric Report NEDC-30299, M. T. Wang, October 1983.

6. Letter S. R. Zimmerman to L. S. Rubenstein, Serial NLS-86-045, NRC TAC No. 59977, Pressurized Thermal Shock, February 4, 1986.

7. Letter S. R. Zimmerman to USNRC Document Control Desk, Serial NLS-87-014, Revised Pressurized Thermal Shock Response, January 16, 1987.

8. Letter R. B. Richey to USNRC Document Control Desk, Serial NLS-88-225, Response to Generic Letter 88-11, December 22, 1988.

9. Letter E. E. Utley to H. R. Denton, Docket No. 50-261, Pressurized Thermal Shock, December 7, 1982.

TABLE 1
H. B. ROBINSON BELTLINE PLATE CHEMISTRIES

PLATE	HEAT #	Ni %	Cr %	Cu %	C %	Mn %	P %	S %	Si %	Mo %
W9807-3	B0650-1	.10	.08	.12	.19	1.43	.012	.020	.25	.48
W9807-5	A5891-1	.10	.07	.15	.19	1.41	.012	.014	.20	.46
W9807-9	P1444-1	.15	.09	.14	.20	1.27	.015	.020	.18	.48
W10201-1	A6623-1	.11	.05	.13	.20	1.40	.010	.017	.20	.47
W10201-2	A6520-1	.25	.08	.15	.20	1.37	.009	.017	.19	.48
W10201-3	B1255-1	.08	.05	.11	.20	1.40	.006	.019	.23	.48
W10201-4	A6604-1	.09	.06	.12	.19	1.35	.007	.019	.23	.48
W10201-5	B1256-1	.12	.07	.10	.20	1.29	.010	.021	.22	.46
W10201-6	B1250-1	.09	.05	.09	.19	1.32	.010	.015	.19	.49

TABLE 2
H. B. ROBINSON BELTLINE PLATE CHEMISTRIES

PLATE	MAX. EOL FLUENCE (n/cm^2, E > 1 MeV) (Best Estimate for 27.4 EFPY)	SHELF ENERGY (ft-lbs) Unirradiated[4]	EOL
W9807-3	1.8×10^{19}	78	77
W9807-5	1.8×10^{19}	69.5	69
W9807-9	1.8×10^{19}	76	75
W10201-1	1.7×10^{19}	52	51
W10201-2	1.7×10^{19}	77	76
W10201-3	1.7×10^{19}	57	56
W10201-4	4.7×10^{19}	59	57
W10201-5	4.7×10^{19}	58.5	57
W10201-6	4.7×10^{19}	73	71

[4] Unirradiated shelf energy values converted from longitudinal to transverse, as reported in Table A1 of Reference 2.

FIGURE 1

UPPER SHELF BEHAVIOR OF H.B. ROBINSON UNIT 2 REACTOR VESSEL SURVEILLANCE PLATES