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SUBJECT: Forwards summary of evaluation demonstrating that Unit 2 projected resistance temp presurized thermal shock (PTS) at proposed extended license expiration date will not exceed PTS screening criteria, for info & review.

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April 10, 1986

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Project Director
PWR Project Directorate No. 6

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

By letter dated January 23, 1986, Duke Power Company (Duke) submitted information in response to the requirements of 10 CFR 50.61, Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events. Within that submittal, Duke concluded that the projected values of RT_{PTS} for all the materials in the reactor vessel beltline region are below the screening criteria at the current expiration date of the operating license for the Oconee Nuclear Station Units 1, 2 and 3.

The current expiration date of the operating Licenses for all three Oconee Units is November 6, 2007 which is based on the Oconee Construction Permit approved on November 6, 1967. By letter dated January 14, 1986, Duke submitted an amendment request to extend the Operating License expiration dates of all the Oconee Units based on the date of issuance of the full power operating license. The proposed expiration dates will be February 6, 2013, October 6, 2013, and July 19, 2014 for Oconee Units 1, 2 and 3, respectively.

As indicated in Duke's submittal of January 23, 1986 letter, both Units 1 and 3 will meet the PTS screening criteria well beyond their proposed Operating License expiration dates in 2013 and 2014, respectively. For Oconee Unit 2, however, the screening criteria may be slightly exceeded for the proposed license expiration date. Furthermore, Duke indicated that in support of the amendment request for license extension submitted on January 14, 1986, evaluations would be performed to demonstrate that the Oconee Unit 2 projected RT_{PTS} at the proposed extended license expiration date will not exceed the PTS screening criteria.

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Attached for your information and review is a summary of this evaluation. The results show that the Oconee Unit 2 reactor vessel will meet the NRC PTS screening criteria of 300 F at the proposed license expiration date of October 6, 2013. This evaluation is based on the latest Oconee Unit 2 data (BAW-1895) reported in our submittal dated January 23, 1986, a plant utilization factor of 0.74 and no change in future fuel cycles. Based on actual experience at the Oconee Nuclear Station the utilization factor is more close to 0.65. The actual plant utilization factor is not expected to exceed the 0.74 for the life of the plant.

Very truly yours,

Hal B. Tucker/

Hal B. Tucker

MAH:slb

Attachment

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NRC Resident Inspector
Oconee Nuclear Station

Oconee-II RT_{PTS} Results for Proposed License Extension

A generic assessment of all operating B&WOG 177 FA reactor pressure vessels with regard to fracture resistance during pressurized thermal shock events was made and reported in BAW-1895.(1) Projected values of RT_{PTS} at specific locations are compared with the NRC screening criterion for all operating B&WOG plants. Tables 4-1 through 4-3 of BAW-1895 contain RT_{PTS} values obtained for Oconee Nuclear Station, Units 1, 2, and 3, that are below, and therefore meet, the NRC PTS screening criterion at the current license expiration date of November 6, 2007. Units 1 and 3 also meet the screening criterion at the proposed license extension dates of February 2, 2013 and July 19, 2014 respectively. Unit 2, however, does not meet the screening criterion at its proposed license extension date of October 6, 2013 using the same assumptions made in BAW-1895 of no changes in future fuel cycles and a 0.80 utilization factor. This analysis demonstrates that Unit 2 will meet the screening criterion on the proposed license extension date if the utilization factor is no greater than 0.74 from January 1986 to October 2013.

The first step in determining if a material will meet the screening criterion on a given date is to determine the projected value of the neutron fluence on that date. The most recently reported projected values for neutron fluence for Oconee Unit 2 are included in OC-IIA capsule report, BAW-1699.(2) Table D-2 from that report is attached. Fluence values in Table D-2 are azimuthal and axial peak values at the inside surface of the reactor vessel. At the time BAW-1699 was written, December 1981, a two dimensional DOT transport calculation had just been made for Oconee Unit 2 using a source in the core averaged over Cycles 2, 3, and 4. Previously, a DOT calculation had been made for Cycle 1. The fluence through Cycle 4 is therefore based on DOT calculations which is the best technique available. Beyond Cycle 4, fluence values in Table D-2 were obtained using a fluence extrapolation technique described in BAW-1485,(3) Page 2-8. It is assumed that the flux above 1 Mev at the reactor vessel is proportional to the flux above 1.8 Mev at the edge of the core in the core liner. The spatially averaged core liner flux above 1.8 Mev is determined at various time steps from PDQ calculations during the design of each fuel cycle. An average over time is then performed to obtain the cycle average. At the time Table D-2 was prepared, cycle designs were available through Cycle 8. The vessel flux values in Table D-2 for Cycles 5 through 8 were obtained by multiplying the average vessel flux for Cycles 2, 3, and 4 (determined by DOT) by the ratio of the cycle core liner flux (core escape flux in Table D-2) to the average core liner flux for Cycles 2, 3, and 4. Cycles beyond 8 were assumed to be identical to Cycle 8. Fluence for each cycle was then determined by multiplying the flux by the cycle design life. Table D-2 gives fluence values as a function of life in EFPY. It should be noted that no assumption regarding utilization is required to obtain the values in Table D-2. The utilization factor is only required to relate life in EFPY with future calendar dates.

Additional DOT calculations have not been made for Oconee Unit 2 since 1981. Therefore, vessel fluence determinations beyond Cycle 4 must continue to be made based on the extrapolation procedure. Table D-2 can be updated in one aspect. The design life times for Cycles 5, 6, and 7 can now be replaced with the actual cycle lifetimes from the fuel cycle reports. This update is shown in Table 1. In addition, fluence values for specific dates of January 23, 1986 (date of submittal of BAW-1895) and October 6, 2013 (proposed license extension date) are included in Table 1. A utilization factor of 0.74 is assumed for the period from January 1986 to October 2013.

The equation to be used in obtaining RT_{PTS} for comparison with the PTS criterion is given on Page 4-1 of BAW-1895. The appropriate equation is:

$$RT_{PTS} = I + M + [-10 + 470\ Cu + 350\ Cu\ Ni]\ f^{0.270}$$

where f is the fluence in units of 10^{19} cm^{-2} (E > 1.0 Mev), Cu is the weight percent of copper, Ni is the weight percent of nickel, I is the initial reference temperature, and M is the margin added to cover uncertainties. The most limiting weld for Oconee Unit 2 is the middle circumferential weld, WF-25. From Table 4.2 in BAW-1895, for this weld

$I = 0$

$M = 59$

$Cu = 0.35$

$Ni = 0.67$

With these vales, the above equation is

$$RT_{PTS} = 59 + 236.58f^{0.270}$$

The peak fluence at the proposed license extension date from Table 1 is 1.06×10^{19} cm^{-2}. Substituting in the above equation gives

$$RT_{PTS} = 299$$

which is below the PTS screening criterion value of 300 for this weld (see Table 4-2, BAW-1895). The screening criterion is met on October 6, 2013, if the utilization factor from January 1986 to October 2013 is not greater than 0.74. With this utilization the criterion is met without changes in future fuel cycles, for example, from low leakage to very low leakage cycles; however, if further operation is considered, then additional flux reduction in future fuel cycles should be considered.

References

1. A. L. Lowe, Jr., et. al., Pressurized Thermal Shock Evaluations in Accordance with 10CFR50.61 for Babcock & Wilcox Owners Group Reactor Pressure Vessels, BAW-1895, Babcock & Wilcox, Lynchburg, Virginia, January 1986.

2. A. L. Lowe, Jr., et. al., Analysis of Capsule OCII-A From Duke Power Company Oconee Nuclear Station, Unit 2, Reactor Vessel Material Surveillance Program, BAW-1699, Babcock & Wilcox, Lynchburg, Virginia, December 1981.

3. C. L. Winterich, Pressure Vessel Fluence Analysis for 177-FA Reactors, BAW-1485, Babcock & Wilcox, Lynchburg, Virginia, June 1978.

Table 1 - Maximum Flux and Fluence on Inside Surface of Oconee Unit 2 Reactor Pressure Vessel

Date	Cycle	EFPD	EFPY	Cumulative EFPY	Core Escape Flux 10^{14} cm^{-2} sec^{-1}	Vessel Flux cm^{-2} sec^{-1}	Vessel Fluence: Interval cm^{-2}	Vessel Fluence: Cumulative cm^{-2}
	1	440	1.205	1.205	0.482	1.39 (+10)	5.28 (+17)	5.28 (+17)
	2	276.8	0.758	1.963	0.560			
	3	289.4	0.792	2.755	0.612 (1)	1.57 (+10)	1.25 (+18)	1.78 (+18)
	4	355	0.972	3.727	0.587			
	5	399.9	1.095	4.822	0.428	1.14 (+10) (4)	3.94 (+17)	2.17 (+18)
	6	408.7	1.119	5.941	0.416	1.11 (+10)	3.92 (+17)	2.56 (+18)
	7	430.9	1.180	7.121	0.425	1.14 (+10)	4.25 (+17)	2.99 (+18)
1/23/86	8	228 (2)	0.624	7.745	0.427	1.14 (+10)	2.23 (+17)	3.21 (+18)
10/6/2013		7487 (3)	20.50	28.24	0.427 (5)	1.14 (+10) (5)	7.38 (+18)	10.59 (+18)

(1) Weighted average over Cycles 2, 3, 4 is 0.587
(2) Part way through Cycle 8
(3) 10118 calendar days and 0.74 utilization factor
(4) Cycles 5 through 8 extrapolated, Example: Cycle 5 Vessel Flux = $\frac{0.428}{0.587}$ x 1.57 (+10) = 1.14 (+10)

(5) Assumed same as Cycle 8

From BAW-1699

Table D-1. Capsule Normalization Constant

	Measured activity, μCi/g[(a)]				
Reaction	A_1 Cycle 1,[(b)] OC-2	Cycles 1B and 2, CR-3	A CR-3 irradiation only	B calculated activity, μCi/g	C = A/B normalization constant[(c)]
^{54}Fe(n,p)^{54}Mn	1.82(+1)	9.52(+2)	9.34(+2)	1.16(+3)	0.80
^{58}Ni(n,p)^{58}Co	7 (-4)	1.94(+3)	1.94(+3)	2.49(+3)	0.78
^{238}U(n,f)^{137}Cs	1.1	4.45	3.35	3.24	1.03
^{277}Np(n,f)^{137}Cs	6.1	2.42(+1)	1.81(+1)	2.09(+1)	0.87
^{238}U(n,f)^{103}Ru	1 (-9)	1.17(+2)	1.17(+2)	1.41(+2)	0.84
^{238}U(n,f)^{106}Ru	9 (-1)	2.69(+1)	2.6 (+1)	2.87(+1)	0.91
^{237}Np(n,f)^{106}Ru	6.2	1.27(+2)	1.21(+2)	1.27(+2)	0.96
^{238}U(n,f)^{144}Ce	6 (-1)	5.8 (+1)	5.74(+1)	5.67(+1)	1.01
^{237}Np(n,f)^{144}Ce	2.6	2.81(+2)	2.78(+2)	3.09(+2)	0.90
^{238}U(n,f)^{95}Zr	7 (-6)	1.04(+2)	1.04(+2)	1.08(+2)	0.96
^{237}U(n,f)^{95}Zr	4 (-5)	6.05(+2)	6.05(+2)	7.13(+2)	0.85

(a) Average of four dosimeter wires from Table E-2.

(b) Obtained from $A = A_2 - A_1 e^{-\lambda t}$ where λ is the decay constant for the product isotope and t is calendar time from EOC-1 in Oconee 2 to EOC-2 in Crystal River 3 (1420 days).

(c) Value for irradiation in Crystal River 3 only. Average of all fission reactions (0.93) was selected as the normalization constant.