Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

December 1, 1992

O. J. "Ike" Zeringue
Vice President, Browns Ferry Nuclear Plant

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - COMPLETION OF COMMITMENT MADE IN RESPONSE TO GENERIC LETTER 92-01, "REACTOR VESSEL STRUCTURAL INTEGRITY"

Reference: Letter from TVA to NRC dated July 7, 1992, "Browns Ferry Nuclear Plant (BFN) - Sequoyah Nuclear Plant (SQN), and Watts Bar Nuclear Plant (WBN) - Response to Generic Letter 92-01 (Reactor Vessel Structural Integrity"

In the referenced letter, TVA committed to provide the staff a summary evaluation of BFN's accumulated fluence at operation below 525°F, the effect on the reference temperature, for nil ductility transion (R_{NDT}) and the effect on Charpy upper shelf energy. The enclosure contains the evaluation results. There are no commitments contained in this letter.

If you have any questions, please contact G. D. Pierce, Interim Manager of Site Licensing, at 205-729-7566.

Sincerely,

O. J. Zeringue

Enclosure
cc: See page 2

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Enclosure
cc (Enclosure):
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ENCLOSURE

BROWNS FERRY NUCLEAR PLANT (BFN)
REACTOR VESSEL STRUCTURAL INTEGRITY

Summary of Accumulated Fluence below 525°F

A review of the Browns Ferry recirculation suction temperatures for the most recent cycles of operation for all three units has been conducted. The cycles chosen for evaluation are Unit 1 Cycle 6, Unit 2 Cycles 4, 5 and 6, and Unit 3 Cycles 5 and 6, which are considered typical for BFN operating cycles. Data for U2C6 included operation through October 20, 1992. For Units 1 and 3, the summary includes the last full and/or partial cycle of operation before shutdown. The data, given in Tables 1 through 6, are presented as a summary of the cumulative fluence as a function of the number of days of core critical operation at each degree Fahrenheit of recirculation temperature below 525°F. The values given are considered conservative in that each day the reactor log indicated operation, a full day of core criticality was assumed. The number of days at each degree of reduced temperature is adjusted to reflect effective full power days (EFPD) based on the indicated reactor operating power level as a percent of full power. The fluence per EFPD (at 1/4 thickness) is based on 1/365 of the EFPY data contained in the reference.

This analysis shows the three BFN reactors to be operated in a similar manner with the recirculation suction temperature typically in the range 525 to 528°F at full or near full power. Operation below 525°F is attributable to transients, limited low power operation and coastdowns preceding refueling outages. The summary data for individual cycles given in Tables 1 through 6 show the accumulated vessel fluence at temperatures below 525°F for individual cycles to range from 0.46×10^{16} to 1.8×10^{16} n/cm^2.

Effect on Reference Temperature

The effects of irradiation on embrittlement are normally quantified through the evaluation of credible surveillance data in accordance with Regulatory Guide 1.99, Revision 2. However, the first surveillance capsules containing Charpy specimens are not scheduled to be removed from the BFN vessels until the end of each unit's cycle which most closely approximates 8 effective full-power years. This projects the initial capsule removal for the BFN to be at the U2C7 refueling outage (one additional cycle).

BROWNS FERRY NUCLEAR PLANT (BFN)
REACTOR VESSEL STRUCTURAL INTEGRITY

The controlling materials for the reactor beltline regions are the circumferential weld WF-154 for Unit 1 and the vertical electroslag welds seams for Units 2 and 3. During the records review for establishing reference temperatures for the beltline materials, specific test results for the electroslag weld seams on the three vessels could not be determined. Likewise, specific test data for the Unit 1 circumferential weld seam could not be established. As a result, the bounding value for procedure qualification records at the time of fabrication of the shell courses were adopted as the RT_{NDT} for the electroslag welds, and the generic bounding value for B&W submerged arc weld metal was adopted as the weld WF-154 RT_{NDT}. These bounding reference temperatures in lieu of actual test data are considered conservative. Therefore, TVA believes that an adequate margin currently exists in the initial RT_{NDT} values to compensate for the limited fluence exposure below 525°F of the Browns Ferry vessels.

When credible surveillance data from the surveillance capsules, becomes available which envelopes those periods of time for operation below 525°F for the Browns Ferry vessels, the actual data will be used to determine the significance of the low temperature operation.

Effect on Upper Shelf Energy (USE)

As summarized in Table 1 of the reference letter, all initial upper shelf energy values for Units 2 and 3 exceed 75 ft- lbs and each are predicted to exceed 65 ft-lbs at End of Life (EOL) (32 Effect Full Power Years [EFPY]). The 15+ ft-lb margin is considered adequate until credible USE data can be obtained at 8 EFPY.

Unit 1 circumferential weld WF-154, which was fabricated with Linde-80 flux and is characterized by bounding chemical and mechanical parameters, is predicted to have an upper shelf energy of 50.8 ft-lbs at 32 EFPY based on the methodology of Regulatory Guide 1.99, Revision 2. When evaluated on the basis of BAW-1803, "Effects of Neutron Irradiation on Linde-80 Weld Metal Upper Shelf Energy," a prediction of 56.8 ft- lbs for the USE at end of life (Enclosure 1, Section 2.a. of the reference letter). Based on the latter evaluation, TVA considers Unit 1 beltline materials to have adequate USE margins.

Table 1

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U1 CYCLE 6

Temperature °F	Days at Temperature	Average Power Level (% of full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	0	0	0	0	0
506.5-507.5	0	0	0	0	0
507.5-508.5	0	0	0	0	0
508.5-509.5	0	0	0	0	0
509.5-510.5	0	0	0	0	0
510.5-511.5	1	0.70	0.7	5.1	0.005
511.5-512.5	3	0.63	1.9	13.9	0.019
512.5-513.5	2	0.65	1.3	9.5	0.028
513.5-514.5	2	0.70	1.4	10.3	0.039
514.5-515.5	4	0.60	2.4	17.6	0.056
515.5-516.5	5	0.70	3.5	25.7	0.082
516.5-517.5	8	0.75	6.0	44.0	0.13
517.5-518.5	7	0.77	5.4	39.6	0.17
518.5-519.5	4	0.675	2.7	19.8	0.19
519.5-520.5	14	0.81	11.3	82.9	0.27
520.5-521.5	8	0.89	7.1	52.1	0.32
521.5-522.5	5	0.86	4.3	31.5	0.35
522.5-523.5	15	0.97	14.6	107.1	0.46
523.5-524.5	13	0.99	42.6	312.4	0.77

*EFPD = Effective Full Power Days
**Estimated 1/4T fluence per EFPD = $2.677 \times 10^{16}/365 = 7.33 \times 10^{13}$ n/cm^2

Table 2

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U2 CYCLE 4

Temperature °F	Days at Temperature	Average Power Level (% of full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	1	0.60	0.6	3.8	0.0038
506.5-507.5	1	0.70	0.7	4.4	0.0082
507.5-508.5	0	0	0	0	0.0082
508.5-509.5	0	0	0	0	0.0082
509.5-510.5	3	0.73	2.2	13.8	0.022
510.5-511.5	3	0.60	1.8	11.3	0.033
511.5-512.5	1	0.70	0.7	4.4	0.038
512.5-513.5	2	0.70	1.4	8.8	0.046
513.5-514.5	3	0.77	2.3	14.4	0.061
514.5-515.5	6	0.78	4.7	29.5	0.090
515.5-516.5	2	0.60	1.2	7.6	0.098
516.5-517.5	6	0.77	4.6	28.8	0.13
517.5-518.5	11	0.84	9.2	57.7	0.18
518.5-519.5	8	0.79	6.3	39.5	0.22
519.5-520.5	8	0.90	7.2	45.1	0.27
520.5-521.5	18	0.94	16.9	106.0	0.38
521.5-522.5	44	0.96	42.2	264.6	0.64
522.5-523.5	64	0.99	63.6	397.5	1.0
523.5-524.5	120	0.99	119.5	744.9	1.78

*EFPD = Effective Full Power Days
**Estimated 1/4T fluence per EFPD = $2.287 \times 10^{16}/365 = 6.27 \times 10^{13}$ n/cm^2

Table 2

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U2 CYCLE 5

Temperature °F	Days at Temperature	Average Power Level (% of full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	0	0	0	0	0
506.5-507.5	0	0	0	0	0
507.5-508.5	0	0	0	0	0
508.5-509.5	1	0.40	0.4	2.5	0.0025
509.5-510.5	4	0.60	2.4	15.0	0.018
510.5-511.5	23	0.60	13.8	86.5	0.10
511.5-512.5	15	0.61	9.2	57.7	0.16
512.5-513.5	16	0.61	9.8	61.4	0.22
513.5-514.5	14	0.64	9.0	56.4	0.28
514.5-515.5	21	0.62	13.0	81.6	0.36
515.5-516.5	7	0.61	4.3	28.0	0.39
516.5-517.5	12	0.67	8.0	50.2	0.44
517.5-518.5	13	0.66	8.6	53.9	0.49
518.5-519.5	19	0.67	12.7	79.6	0.57
519.5-520.5	23	0.62	14.3	89.7	0.66
520.5-521.5	13	0.68	8.8	55.2	0.72
521.5-522.5	20	0.77	15.4	96.6	0.81
522.5-523.5	18	0.89	16.0	100.3	0.91
523.5-524.5	42	0.99	41.6	260.8	1.17

*EFPD = Effective Full Power Days
**Estimated 1/4T fluence per EFPD = $2.287 \times 10^{16}/365 = 6.27 \times 10^{13}$ n/cm^2

Table 4

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U2 CYCLE 6

Temperature °F	Days at Temperature	Average Power Level (% of Full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	0	0	0	0	0
506.5-507.5	0	0	0	0	0
507.5-508.5	0	0	0	0	0
508.5-509.5	0	0	0	0	0
509.5-510.5	0	0	0	0	0
510.5-511.5	0	0	0	0	0
511.5-512.5	1	0.70	0.7	4.4	0.0044
512.5-513.5	0	0	0	0	0.0044
513.5-514.5	3	0.73	2.2	12.8	0.018
514.5-515.5	3	0.53	1.6	10.0	0.028
515.5-516.5	3	0.50	1.5	9.4	0.038
516.5-517.5	12	0.69	8.3	52.0	0.090
517.5-518.5	13	0.72	9.4	58.9	0.15
518.5-519.5	7	0.80	5.6	35.1	0.18
519.5-520.5	4	0.775	3.1	19.4	0.20
520.5-521.5	6	0.80	4.8	30.1	0.23
521.5-522.5	11	0.745	8.2	51.4	0.28
522.5-523.5	7	0.74	5.2	32.6	0.32
523.5-524.5	24	0.975	23.4	146.7	0.46

*EFPD = Effective Full Power Days

**Estimated 1/4T fluence per EFPD = $2.287 \times 10^{16}/365 = 6.27 \times 10^{13}$ n/cm^2

Table 5

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U3 CYCLE 5

Temperature °F	Days at Temperature	Average Power Level (% of full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	0	0	0	0	0
506.5-507.5	0	0	0	0	0
507.5-508.5	0	0	0	0	0
508.5-509.5	0	0	0	0	0
509.5-510.5	0	0	0	0	0
510.5-511.5	2	0.60	1.2	7.4	0.0074
511.5-512.5	3	0.50	1.5	9.2	0.017
512.5-513.5	2	0.70	1.4	8.6	0.025
513.5-514.5	3	0.60	1.8	11.1	0.036
514.5-515.5	6	0.75	4.5	27.7	0.064
515.5-516.5	5	0.68	3.4	21.9	0.085
516.5-517.5	6	0.78	4.7	28.9	0.11
517.5-518.5	9	0.80	7.2	44.3	0.16
518.5-519.5	5	0.86	4.3	26.4	0.18
519.5-520.5	7	0.87	6.1	37.5	0.22
520.5-521.5	8	0.875	7.0	43.0	0.26
521.5-522.5	9	0.92	8.3	51.0	0.32
522.5-523.5	17	0.935	15.9	9*	0.41
523.5-524.5	26	0.965	25.1	154.4	0.57

*EFPD = Effective Full Power Days
**Estimated 1/4T fluence per EFPD = $2.245 \times 10^{16}/365 = 6.15 \times 10^{13}$ n/cm^2

Table 6

SUMMARY OF ACCUMULATED 1/4T FLUENCE FOR RECIRC SUCTION TEMPERATURE BELOW 525°F
BFN U3 CYCLE 6

Temperature °F	Days at Temperature	Average Power Level (% of Full power)	Adjusted Effective Full Power Days	Estimated** Fluence (n/cm^2 per EFPD* $\times 10^{13}$)	Cumulative Fluence ($n/cm^2 \times 10^{16}$)
505.5-506.5	0	0	0	0	0
506.5-507.5	0	0	0	0	0
507.5-508.5	0	0	0	0	0
508.5-509.5	1	0.60	0.6	3.7	0.0037
509.5-510.5	1	0.60	0.6	3.7	0.0074
510.5-511.5	0	0	0	0	0.0074
511.5-512.5	0	0	0	0	0.0074
512.5-513.5	0	0	0	0	0.0074
513.5-514.5	2	0.65	1.3	8.0	0.015
514.5-515.5	2	0.45	0.9	5.5	0.021
515.5-516.5	1	0.30	0.3	1.8	0.023
516.5-517.5	0	0	0	0	0.023
517.5-518.5	1	0.70	0.7	4.3	0.027
518.5-519.5	0	0	0	0	0.027
519.5-520.5	1	0.90	0.9	5.5	0.032
520.5-521.5	1	0.90	0.9	5.5	0.038
521.5-522.5	0	0	0	0	0.038
522.5-523.5	4	^.95	3.8	23.4	0.061
523.5-524.5	18	0.906	16.3	100.2	0.16

Plant shutdown during Cycle 6

*EFPD = Effective Full Power Days

**Estimated 1/4T fluence per EFPD = $2.245 \times 10^{16}/365 = 6.15 \times 10^{13}$ n/cm^2

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