10 CFR 54

May 31, 2005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

Gentlemen:

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

BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 1, 2, AND 3 - LICENSE RENEWAL APPLICATION (LRA) – RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION CONCERNING 4.7.7 TIME LIMITED AGING ANALYSIS (TLAA) FOR CORE PLATE RELAXATION OF BOLTS (TAC NOS. MC1704, MC1705, AND MC1706)

By letter dated December 31, 2003, TVA submitted, for NRC review, an application pursuant to 10 CFR 54, to renew the operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2, and 3. As part of its review of TVA's LRA, the NRC staff, through a letter dated March 3, 2005, identified additional follow up questions for LRA Section 4.7.7, TLAA. The question concentrates on the 4.7.7 TLAA for Core Plate Relaxation of bolts and methodology and assumptions used for this evaluation.

The enclosure to this letter contains the specific NRC requests for additional information and the corresponding TVA responses.

If you have any questions regarding this information, please contact Ken Brune, Browns Ferry License Renewal Project Manager, at (423) 751-8421.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 31st day of May 2005.

Sincerely,

Original signed by:

Mike D. Skaggs

Enclosure:
cc: See page 3

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s://Licensing/Lic/BFN LR Clarification For Core Plate Relaxation of Bolts.doc

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3
LICENSE RENEWAL APPLICATION (LRA)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING 4.7.7 TIME LIMITED AGING ANALYSIS (TLAA)
FOR CORE PLATE RELAXATION OF BOLTS

(SEE ATTACHED)

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3
LICENSE RENEWAL APPLICATION (LRA)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI) CONCERNING 4.7.7 TIME LIMITED AGING ANALYSIS (TLAA) FOR CORE PLATE RELAXATION OF BOLTS

By letter dated December 31, 2003, TVA submitted, for NRC review, an application pursuant to 10 CFR 54, to renew the operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2, and 3. As part of its review of TVA's LRA, the NRC staff, through a letter dated March 3, 2005, identified additional follow up questions for LRA Section 4.7.7, TLAA. The question concentrates on the 4.7.7 TLAA for Core Plate Relaxation of bolts and methodology and assumptions used for this evaluation. This enclosure contains the specific NRC requests for additional information and the corresponding TVA responses.

NRC RAI 4.7.7

In Section 4.7.7 of the LRA, the loss of preload of the core plate hold-down bolts due to thermal and irradiation effects was evaluated in accordance with the requirements of 10 CFR 54.21(c)(1)(ii). For the 40-year lifetime, the BWRVIP-25 concluded that all core plate hold-down bolts will maintain some preload throughout the life of the plant. For the period of extended operation, the expected loss of preload was assumed to be 20%, which bounds the original BWRVIP analysis that was prepared to bound the majority of plants including BFN Units after operating for 20 additional years. With a loss of 20% in preload, the core plate will maintain sufficient preload to prevent sliding under both normal and accident conditions. Based on this assumption, the applicant concludes that the loss of preload is acceptable for the period of extended operation.

NRC RAI 4.7.7-1

Demonstrate how the BWRVIP-25 analysis can be applied to the BFN units based on the configuration and the geometry of core plate hold-down bolts and the reactor environment (temperature and neutron fluence) assumed in the original report.

TVA Response to RAI-4.7.7-1

The core plate configuration for BFN is identified properly in Figure 2-4 of BWRVIP-25. Therefore, BFN was specifically considered in the original BWRVIP-25 evaluation, incorporating typical values of temperature and fluence. An analysis was initially performed for a 40-year plant life. The analysis was later performed for a 60-year plant life as discussed in Paragraph B.4 of BWRVIP-25. This section of the document addressed License Renewal. This initial BWRVIP-25 based analysis assumed 20% relaxation in the core plate bolts over the 60-year operating period.

To more accurately address the BFN units for the combined effects of Extended Power Uprate (EPU) in conjunction with License Renewal, a plant-specific calculation was performed that encompassed all the BFN units. This evaluation incorporated the BFN specific core plate geometry and temperature. It also used the BFN fluence calculation which was performed considering EPU operating power and time conditions. The maximum fluence that was applicable to the bolts in the highest fluence region of the core plate was determined to be 5×10^{19} n/cm^2 at the end of the 60-year plant life. The resultant relaxation was determined to be 15% based on GE Design Documents; the basis of this GE document is discussed in greater detail in the response to RAI 4.7.7-2. The analysis assumed that all of the bolts were at this fluence even though many bolts experience a lower fluence depending on their specific location. The plant-specific analysis is bounded by the original application that assumed a higher value of 20% relaxation.

NRC RAI-4.7.7-2

Please explain the following questions with the preload determined to be 20%.

(a) Identify the temperature of the bolts during the normal operation and the projected neutron fluence to be received by the bolts at the end of extended period of operation.

(b) Explain how it was determined that the effect of temperature and neutron fluence result in a 20% loss of preload.

(c) Provide a detailed description of the methodology and data used in Browns Ferry to perform the analysis as described in (b). Include the basis for the relaxation curves.

TVA Response to RAI-4.7.7-2(a)

The normal operating temperature for the core plate bolts is 550°F (288°C). For the BFN units, the projected fluence was determined to be 5 x 10^{19} n/cm^2 for a 60-year lifetime (assuming a 90% capacity factor) for the bolt at the peak radial location. The arrangement of the core plate bolts around the periphery of the core plate assures that many of the bolts experience a significantly lower lifetime fluence than the 5 x 10^{19} n/cm^2 value used.

TVA Response to RAI-4.7.7-2(b)

The plant specific evaluation used GE Material Design Documents as the basis of assigning relaxation as a function of cumulative fluence. The applicable Design Document for irradiated stainless steel properties assumed 288°C as the basis design temperature. This proprietary document was developed and verified by the GE Materials Engineering Group in the 1970's timeframe. The document, typical of company design documents, was based upon a combination of GE internal reports and industry data to evaluate stress relaxation. The curves are GE Proprietary information, and can be made available for NRC review upon request to GE.

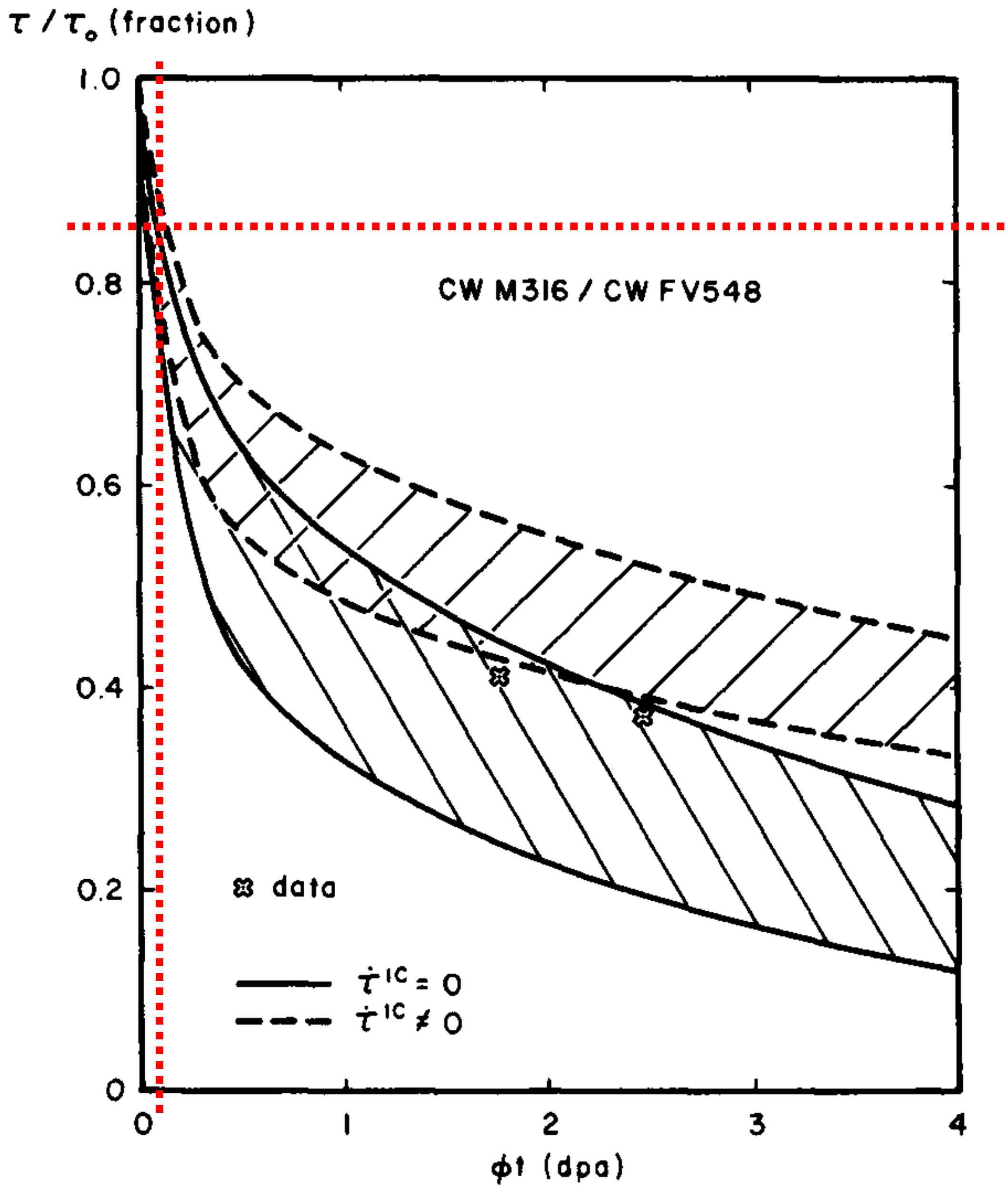
TVA Response to RAI-4.7.7-2(c)

As stated earlier, the BFN calculation was performed based on BFN specific geometry, fluence and temperature. The calculation used the highest bolt end of life fluence as the basis of the reduced pre-load calculation for all of the bolts. The BFN fluence conditions and the expected relaxation made use of either GE methods or GE Design documents. The confidence in the relaxation value that was employed can be independently confirmed using other reports available to the NRC. Specifically, relaxation as a function of fluence has been presented in the BWRVIP-99 (Reference 1) in Section 7 of the report. This section deals directly with stress relaxation as a function of fluence. Figure 7-13 from BWRVIP-99 is attached; it shows data and modeling projections of relaxation versus fluence in displacements per atom (dpa). One dpa is equivalent to a fluence of 6-7 x 10^{20} n/cm^2. It is noted that the data presented in the figure was measured on Type 316 stainless steel material. Comparison with Type 304 data is considered appropriate in that the two commercial alloys have the same single-phase austenitic microstructure and crystal structure, with no precipitates present in either alloy. The only compositional difference is the addition of Mo to Type 316 to increase pitting resistance. The mechanical properties are essentially identical at 550°F. Therefore, the effects of irradiation on stress relaxation for both alloys is essentially the same.

Therefore, the fluence of interest for the BFN calculations is 10% of that or 0.1 dpa. The dotted lines depict that fluence level and one can see that the projected relaxation is less than 20%. This supports the value used in the analysis and, in turn, the GE Design Curve.

References

1. "BWRVIP-99: BWR Vessel and Internals Project: Crack Growth Rates in Irradiated Stainless Steels in BWR Internals Components," TR-1003018, December 2001.
2. J.P. Foster, "Analysis of In-reactor Stress Relaxation Using Irradiation Creep Models", Proc. *Irradiation Effects on the Microstructure and Properties of Metals*, ASTM STP611, p.32, 1976.



BWRVIP-99: Figure 7-13. Radiation creep relaxation of shear stresses in springs of 20% cold worked 316 stainless steel along with modeling curves [Reference 2]. The dotted line represents 0.1 dpa which is equivalent to a fluence of ~6-7 x 10^{19} n/cm.