March 28, 2002

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 2 AND 3 - ISSUANCE OF AMENDMENTS REGARDING THE PRESSURE-TEMPERATURE LIMITS FOR THE REACTOR PRESSURE VESSEL (TAC NOS. MB2753 AND MB2754)

Dear Mr. Scalice:

The Commission has issued the enclosed Amendment Nos. 275 and 233 to Facility Operating Licenses Nos. DPR-52 and DPR-68 for the Browns Ferry Nuclear Plant, Units 2 and 3, respectively. These amendments are in response to your application dated August 17, 2001, as supplemented by letters dated December 14, 2001, and February 6, 2002. These amendments revise the pressure-temperature (P-T) limits for the reactor pressure vessels. The revised Unit 2 P-T limits are valid through 17.2 effective full power years (EFPYs) and for Unit 3 through 13.1 EFPYs.

A copy of the Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

/RA/

Kahtan N. Jabbour, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-260 and 50-296

Enclosures: 1. Amendment No. 275 to License No. DPR-52
2. Amendment No. 233 to License No. DPR-68
3. Safety Evaluation

cc w/enclosures: See next page

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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-260

BROWNS FERRY NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 275
License No. DPR-52

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated August 17, 2001, as supplemented by letters dated December 14, 2001, and February 6, 2002, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Facility Operating License No. DPR-52 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 275, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard P. Correia, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: March 28, 2002

ATTACHMENT TO LICENSE AMENDMENT NO. 275

FACILITY OPERATING LICENSE NO. DPR-52

DOCKET NO. 50-260

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
3.4-29	3.4-29

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-296

BROWNS FERRY NUCLEAR PLANT, UNIT 3

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 233
License No. DPR-68

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated August 17, 2001, as supplemented by letters dated December 14, 2001, and February 6, 2002, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Facility Operating License No. DPR-68 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 233, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard P. Correia, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: March 28, 2002

ATTACHMENT TO LICENSE AMENDMENT NO. 233

FACILITY OPERATING LICENSE NO. DPR-68

DOCKET NO. 50-296

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
3.4-29	3.4-29

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 275 TO FACILITY OPERATING LICENSE NO. DPR-52

AND AMENDMENT NO. 233 TO FACILITY OPERATING LICENSE NO. DPR-68

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 2, AND 3

DOCKET NOS. 50-260, AND 50-296

1.0 INTRODUCTION

By letter dated August 17, 2001 (Reference 1), as supplemented by letters dated December 14, 2001 (Reference 2), and February 6, 2002 (Reference 3), the Tennessee Valley Authority (TVA or the licensee) submitted a request for changes to the Browns Ferry Plant, Units 2 and 3 Technical Specifications (TS). The requested changes would update the reactor pressure vessel (RPV) pressure-temperature (P-T) limits for Unit 2 to 17.2 effective full-power years (EFPYs) and for Unit 3 to13.1 EFPYs. The December 14, 2001, and February 6, 2002, letters provided clarifying information that did not change the initial proposed no significant hazards consideration determination or expand the scope of the original *Federal Register* notice.

The proposed changes to the P-T limits were based, in part, on the use of Code Case N-640 of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME). In order to utilize this Code Case, TVA requested an exemption from the requirements of Appendix G to Title 10, *Code of Federal Regulations* (10 CFR), Part 50, which requires the use of Appendix G to Section XI of the ASME Code for developing RPV P-T limits. The exemption was issued on March 21, 2002.

2.0 EVALUATION

2.1 P/T LIMITS

2.1.1 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) has established requirements in 10 CFR Part 50 to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. The staff evaluates the P-T limit curves based on the following NRC regulations and guidance: Appendix G to 10 CFR Part 50; Generic Letter (GL) 88-11; GL 92-01, Rev. 1; GL 92-01, Rev. 1, Supplement 1; Regulatory Guide (RG) 1.99, Rev. 2; and Standard Review Plan (SRP) Section 5.3.2. GL 88-11 advised licensees that the staff would use RG 1.99, Rev. 2 to review

P-T limit curves. RG 1.99, Rev. 2, contains methodologies for determining the increase in transition temperature and the decrease in upper-shelf energy resulting from neutron radiation. GL 92-01, Rev. 1, requested that licensees submit their RPV data for their plants to the staff for review. GL 92-01, Rev. 1, Supplement 1, requested that licensees provide and assess data from other licensees that could affect their RPV integrity evaluations. These data are used by the staff as the basis for the review of P-T limit curves. Appendix G to 10 CFR Part 50 requires that P-T limit curves for the RPV be at least as conservative as those obtained by applying the methodology of Appendix G to Section XI of the ASME, 1995 Edition through the 1996 Addenda.

SRP Section 5.3.2 provides an acceptable method of determining the P-T limit curves for ferritic materials in the beltline of the RPV based on the linear elastic fracture mechanics methodology of Appendix G to Section XI of the ASME Code. The basic parameter of this methodology is the stress intensity factor K_I, which is a function of the stress state and flaw configuration. Appendix G requires a safety factor of 2.0 on stress intensities resulting from reactor pressure (K_{Im}) during normal and transient operating conditions, and a safety factor of 1.5 for hydrostatic testing. A safety factor of 1.0 is applied to stress intensities resulting from thermal loads (K_{It}) for both normal operating and hydrostatic testing conditions. The methods of Appendix G postulate the existence of a sharp surface flaw in the RPV that is normal to the direction of the maximum stress. This flaw is postulated to have a depth that is equal to 1/4 of the RPV beltline thickness and a length equal to 1.5 times the RPV beltline thickness. The critical locations in the RPV beltline region for calculating heatup and cooldown P-T curves are the 1/4 thickness (1/4T) and 3/4 thickness (3/4T) locations, which correspond to the maximum depth of the postulated inside surface and outside surface defects, respectively.

The methodology found in Appendix G to Section XI of the ASME Code requires that licensees determine the adjusted reference temperature (ART or adjusted RT_{NDT}). The ART is defined as the sum of the initial (unirradiated) reference temperature (initial RT_{NDT}), the mean value of the adjustment in reference temperature caused by irradiation (ΔRT_{NDT}), and a margin (M) term.

The ΔRT_{NDT} is a product of a chemistry factor (CF) and a fluence factor. The CF is dependent upon the amount of copper and nickel in the material and may be determined from tables in RG 1.99, Rev. 2, or from surveillance data. The fluence factor is dependent upon the neutron fluence at the maximum postulated flaw depth. The M term is dependent upon whether the initial RT_{NDT} is a plant-specific or a generic value and whether the CF was determined using the tables in RG 1.99, Rev. 2, or surveillance data. The M term is used to account for uncertainties in the values of the initial RT_{NDT}, the copper and nickel contents, the fluence and the calculational procedures. RG 1.99, Revision 2, describes the methodology to be used in calculating the M term.

2.1.2 LICENSEE EVALUATION

The licensee requested, pursuant to 10 CFR 50.60(b), an exemption to use ASME Code Case N-640 as the basis for establishing the P-T limit curves. ASME Code Case N-640 permits application of the lower bound static initiation fracture toughness (K_{IC}) curve as the basis for establishing the P-T curves in lieu of using the lower bound crack arrest fracture toughness (K_{IA}) curve which is invoked by Appendix G to Section XI of the ASME Code.

The licensee submitted ART calculations and P-T limit curves valid for up to 17.2 EFPY of facility operation for BFN Unit 2 and valid for up to 13.1 EFPY of facility operation for BFN Unit 3. These limits of applicability were established such that the limiting material in each

unit's RPV would have the same ART value and thus the P-T limit curves for each unit would be essentially the same. For both BFN Unit 2 and Unit 3, the licensee determined that the most limiting materials at the 1/4T and 3/4T locations were the RPVs' axial electroslag welds. The ART value for each unit's axial electroslag welds at the 1/4T location was 110.6°F (note that since the licensee proposed combined heatup/cooldown curves, evaluation of the 3/4T location, which may be limiting during heatup transients, was not required since the evaluation of the cooldown transient is limiting). The neutron fluence used in the ART calculation was 6.83 x 10^{17} n/cm^2 at the 1/4T location for each unit. The ΔRT_{NDT} value at the 1/4T location was 39.9°F. The initial RT_{NDT} for the units' axial electroslag weld has been generically determined previously to be 23.1°F. The M term used in calculating the ART for the axial electroslag weld was 47.6°F based on two times the square-root-sum-of-squares combination of the accepted margin for the initial property uncertainty (σ_I = 13°F) and the accepted margin for shift uncertainty (σ_Δ = 19.95°F).

Regarding the detailed fracture mechanics evaluation performed to establish the proposed BFN Unit 2 and Unit 3 P-T limits, TVA submitted information on their methodology for determining the applied stress intensity at the tip of the postulated 1/4T flaw due to thermal loading (i.e., K_{IT}) in an enclosure to their December 14, 2001 letter. This information, along with knowledge of the applied stress intensity at the tip of the postulated 1/4T flaws due to pressure loads and the material property information cited above, permitted the staff to evaluate the acceptability of the proposed BFN Unit 2 and Unit 3 1 P-T limit curves.

2.1.3 STAFF EVALUATION

As mentioned above, the licensee requested an exemption to use ASME Code Case N-640 as the basis for establishing the P-T limit curves. Use of the K_{IC} curve in determining the lower bound fracture toughness curve in the development of P-T operating limits is more technically correct than use of the K_{IA} curve. The K_{IC} curve appropriately implements the use of static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a RPV. The staff concluded that P-T curves based on the K_{IC} fracture toughness curve referenced by ASME Code Case N-640 will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operation. In addition, implementation of the proposed P-T curves, as allowed by ASME Code Case N-640, does not significantly reduce the margin of safety.

The staff performed an independent calculation of the ART values for the limiting material using the methodology in RG 1.99, Revision 2. Based on these calculations, the staff verified that the licensee's limiting materials for the BFN Unit 2 and Unit 3 RPVs were the axial electroslag welds. The staff's calculated ART value for the limiting material agreed with the licensee's calculated ART value of 110.6°F.

The staff evaluated the licensee's P-T limit curves for acceptability by performing a finite set of check calculations using the methodology referenced in the ASME Boiler and Pressure Vessel Code (as indicated by SRP 5.3.2) based on information submitted by the licensee. The staff verified that the licensee's proposed P-T limits satisfy the requirements in Paragraph IV.A.2 of Appendix G of 10 CFR Part 50. Specifically, the staff concluded that the P-T limit curves submitted by the licensee were as conservative as those which would be generated by the staff's application of the methodology specified in Appendix G to Section XI of the ASME Code, as modified by ASME Code Case N-640. Therefore, the staff determined that the licensee's proposed P-T limit curves were acceptable for operation of the BFN Unit 2 RPV through 17.2 EFPY and the BFN Unit 3 RPV through 13.1 EFPY.

In addition to beltline materials, Appendix G of 10 CFR Part 50 also imposes minimum operational temperatures at the closure head flange based on the reference temperature for the flange material. Section IV.A.2 of Appendix G states that when the pressure exceeds 20 percent of the preservice system hydrostatic test pressure, the temperature of the closure flange regions highly stressed by the bolt preload must exceed the reference temperature of the material in those regions by at least 160°F for core critical operation, 120°F for core not critical operation, and by 90°F for hydrostatic pressure tests and leak tests. In addition, the most limiting requirements for operation at pressures below 20 percent of the preservice system hydrostatic test pressure would require that the flange temperature must exceed the reference temperature of the material in those regions by at least 60°F, which defines the RPV head boltup temperature. Based on the limiting flange RT_{NDT} values for each BFN unit, the staff has determined that the proposed P-T limits have satisfied the requirements for the closure flange region for RPV head boltup, for core critical operation, for core not critical operation, and for inservice leak and hydrostatic testing.

2.1.4 SUMMARY

The staff concludes that the proposed P-T limits curves for each of the pressure test, core not critical and core critical conditions satisfy the requirements in Appendix G to Section XI of the ASME Code, as modified by Code Case N-640, and Appendix G of 10 CFR 50. The proposed P-T limits also satisfy Generic Letter 88-11, because the method in RG 1.99, Revision 2, was used to calculate the ART. Hence, the proposed P-T limit curves may be incorporated into the BFN Unit 2 and Unit 3 TS and shall be valid through 17.2 EFPY of operation for BFN Unit 2 and 13.1 EFPY of operation for BFN Unit 3.

2.2 FLUENCE

2.2.1 ESTIMATED PRESSURE VESSEL FLUENCE

For the initial license, the licensee used a fluence estimate for 32 EFPYs (for both Units) of 1.07×10^{18} n/cm$^{2.}$ The current PT curves have been derived from this value. In 1994 at 8.0 EFPY a surveillance capsule was removed from Unit 2. Evaluation of this capsule indicated that the projected fluence value at 32 EFPYs was 43 percent lower than the original estimate. This comparison established a considerable conservatism in the existing fluence value for both Units. The 1994 capsule measurement was analyzed using advanced methods, thus, increased the credibility of the conservatism of the existing estimates. The Browns Ferry units are of the same design and are operated in a similar manner.

The licensee implemented a 5 percent power uprate on Cycle 11 for Unit 2 and Cycle 9 for Unit 3 in May 1999 and October 1998, respectively. At that time, the original fluence estimate for 32 EFPY was increased to 1.12×10^{18} n/cm^2 (i.e. 5 percent higher than the previous value). Core loadings for BWR [Boiling Water Reactor] power uprates tend to increase the power of the outer assemblies, thus, a 5 percent power increase could result in a 5 - 10 percent increase in the core leakage and the expected end of license (EOL) value of the vessel fluence. The Unit 2 power uprate was implemented at about half way to the EOL, while the Unit 3 the power uprate was implemented about a third of the EOL.

For Unit 2, the licensee is proposing to use a fluence estimate based on 19.5 EFPY for a period of applicability of 17.2 EFPY. This provides a 13.4 percent conservatism to the licensing fluence value. The 43 percent conservatism from the 1994 capsule remains the same for the

19.5 EFPY estimate, therefore, the total estimated conservatism is over 56 percent. The power uprate evens-out the expected fluence increase. The estimated conservatism of 56 percent is acceptable for the requested period of applicability of 17.2 EFPYs. For Unit 3 the licensee is proposing to use a fluence estimate based on 19.5 EFPY for a period of applicability of 13.1 EFPY. This provides a 32.8 percent conservatism to the licensing fluence value. This conservatism added to the 43 percent conservatism from the 1994 capsule amounts to 75.8 percent conservatism in the fluence value. However, the power uprate may result in a fluence estimate deficit of about 3.5 percent, resulting in a net conservatism of 72.3 percent. This is acceptable for the requested period of applicability of 13.1 EFPYs.

2.2.2 TS CHANGES

The proposed changes affect TS 3.4.9 “Pressure Temperature Limits” and in particular Figures 3.4.9-1 for both units. The Figures are being replaced to reflect: (a) minimum temperature for pressure tests (b) minimum temperature vs pressure curve for heatup and cooldown and (c) minimum temperature vs pressure for critical core operation.

In addition Figures 3.4.9-1 indicate the term of applicability and compliance with the guidance of RG 1.99. The staff finds that these changes represent the 17.2 EFPY for Unit 2 and 13.1 EFPY for Unit 3 period of applicability, thus, are acceptable.

2.2.3 SUMMARY

This review indicated that the uncertainties in the existing fluence evaluations could not be precisely quantified as is the case with all of the fluence estimates of the same vintage plants as Browns Ferry. However, the staff finds that margins much greater than the expected uncertainties have been built into the estimated fluence values for the proposed EOL P-T curves. The staff finds a reasonable assurance of safety for the fluence values of the proposed P-T curves for Browns Ferry Units 2 and 3 for 17.2 and 13.1 EFPYs respectively. Therefore, the staff finds the proposed fluence values acceptable for use in developing the corresponding P-T curves.

3.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Alabama State official was notified of the proposed issuance of the amendment. The State official had no comments.

4.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (66 FR 48291). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

5.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

6.0 REFERENCES

1. Letter from T.E. Abney Tennessee Valley Authority to NRC "Browns Ferry Nuclear Plant (BFN) - Units 2 and 3 - Technical Specifications (TS) Change No. 414 - Pressure - Temperature Curve Update," dated August 17, 2001.

2. Letter from T.E. Abney Tennessee Valley Authority to NRC "Browns Ferry Nuclear Plant (BFN) - TVA Responses to NRC Requests for Additional Information (RAI) Regarding Units 2 and 3 - Technical Specifications (TS) Change No. 414 - Pressure - Temperature (P-T) Curve Update," dated December 14, 2001.

3. Letter from T.E. Abney Tennessee Valley Authority to NRC "Browns Ferry Nuclear Plant (BFN) - Reduction in Requested Effective Full Power Years (EFPY) for Technical Specifications (TS) Change No. 414 - Pressure - Temperature (P-T) Curve Update," dated February 6, 2002.

Principal Contributor: Lambros Lois, NRR
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Date: March 28, 2002

Mr. J. A. Scalice
Tennessee Valley Authority

BROWNS FERRY NUCLEAR PLANT

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