UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 24, 2011

Mr. R. M. Krich
Vice President, Nuclear Licensing
Tennessee Valley Authority
3R Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 2 - SAFETY EVALUATION FOR RELIEF REQUEST 2-ISI-43, FOR THE FOURTH 10-YEAR INSERVICE INPSECTION INTERVAL (TAC NO. ME3721)

Dear Mr. Krich:

By letter dated March 31, 2010 (Agencywide Documents Access and Management System Accession No. ML100920542), Tennessee Valley Authority, licensee for Browns Ferry Nuclear Plant (BFN), Unit 2, submitted a proposed alternative under Request for Relief (RR) 2-ISI-43, in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a(a)(3)(i). In RR 2-ISI-43, the licensee requested Nuclear Regulatory Commission (NRC) authorization to revise the inspection requirements for certain reactor pressure vessel nozzle-to-vessel welds and nozzle inner radii from those based on American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," without using the Code Case-specified visual examination.

Based on the information provided in the relief request, the NRC staff concludes the licensee's proposed alternative provides an acceptable level of quality and safety. Therefore, the licensee's proposed alternative is authorized in accordance with 10 CFR 50.55a(a)(3)(i) for the fourth 10-Year inservice inspection program interval at BFN, Unit 2, which begins May 25, 2011, and ends May 24, 2021.

If you have any questions regarding this matter, please contact Christopher Gratton at (301) 415-1055.

Sincerely,

Douglas A. Broaddus, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-260

Enclosure: Safety Evaluation

cc w/enclosure: Distribution via Listserv

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NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF 2-ISI-43 FOR FACILITY OPERATING LICENSE NO. DPR-52

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-260

1.0 INTRODUCTION

By letter dated March 31, 2010 (Agencywide Documents Access and Management System Accession No. ML100920542), Tennessee Valley Authority (TVA) requested changes to the inspection program for the fourth 10-year inspection interval for Browns Ferry Nuclear Plant (BFN), Unit 2.

The proposed changes in Relief Request 2-ISI-43 would revise the inspection requirements for certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii from those based on American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," without using the Code Case-specified visual (VT-1) examination.

2.0 REGULATORY EVALUATION

Inservice inspection (ISI) of the ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as a way to detect anomaly and degradation indications so that structural integrity of these components can be maintained. This is required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Paragraph 50.55a(a)(3) of 10 CFR states that alternatives to the requirements of paragraph (g) may be used, when authorized by the Nuclear Regulatory Commission (NRC), if: (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For all RPV nozzle-to-vessel shell welds and nozzle inner radii, ASME Code, Section XI requires 100 percent inspection during each 10-year ISI interval. However, ASME Code Case N-702 proposes an alternative that reduces the inspection of RPV nozzle-to-vessel shell welds and nozzle inner radius areas from 100 percent to 25 percent of the nozzles for each nozzle type during each 10-year interval. The NRC has approved the Boiling Water reactor Vessel and

Internals Project (BWRVIP) report, "BWRVIP-108: BWR Vessel and Internals Project, Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii," that contains the technical basis supporting ASME Code Case N-702. The staff's December 19, 2007, safety evaluation (SE) regarding the BWRVIP-108 report specified plant-specific requirements which must be satisfied by applicants who propose to use ASME Code Case N-702.

Similar applications have been approved for several plants, including Dresden Nuclear Power Station, Units 2 and 3, Hope Creek Generating Station, and Cooper Nuclear Station.

3.0 TECHNICAL EVALUATION

The December 19, 2007, staff SE for the BWRVIP-108 report specified plant-specific requirements that must be met for applicants proposing to use this alternative. This submittal intended to demonstrate that the relevant BFN, Unit 2, RPV nozzle-to-vessel welds and the inner radii meet these plant-specific requirements so that Relief Request 2-ISI-43 can be approved.

The following plant-specific requirements are specified in the December 19, 2007, SE for the BWRVIP-108 report supporting use of the ASME Code Case N-702:

> Each licensee should demonstrate the plant-specific applicability of the BWRVIP-108 report to their units in the relief request by showing that all the following general and nozzle-specific criteria are satisfied:
>
> (1) the maximum RPV heatup/cooldown rate is limited to less than 115 °F/hour;
>
> For recirculation inlet nozzles
>
> (2) $(pr/t)/C_{RPV} < 1.15$
>
> p = RPV normal operating pressure,
> r = RPV inner radius,
> t = RPV wall thickness, and
> CRPV = 19332...;
>
> (3) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)]/CNOZZLE < 1.15$
>
> p = RPV normal operating pressure,
> r_o = nozzle outer radius,
> r_i = nozzle inner radius, and
> CNOZZLE = 1637...;

For recirculation outlet nozzles

(4) $(pr/t)/C_{RPV} < 1.15$

p = RPV normal operating pressure,
r = RPV inner radius,
t = RPV wall thickness, and
CRPV = 16171...; and

(5) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)]/CNOZZLE < 1.15$

p = RPV normal operating pressure,
r_o = nozzle outer radius,
r_i = nozzle inner radius, and
CNOZZLE = 1977....

This plant-specific information was required by the NRC staff to ensure that the probabilistic fracture mechanics (PFM) analysis documented in the BWRVIP-108 report applies to the RPV of the applicant's plant.

3.1 Licensee Evaluation

Component(s) for which Alternative is Requested (ASME Code Class 1)

Reactor Recirculation Inlet Nozzles - N2A, N2B, N2C, N2D, N2E, N2F, N2G, N2H, N2J, and N2K

Main Steam Nozzles - N3A, N3B, N3C, and N3D

Core Spray Nozzles - N5A and N5B

RPV Head Nozzles - N6A, N6B, and N7

Jet Pump Instrumentation Nozzles - N8A and N8B

Note that the RPV recirculation outlet nozzles, feedwater nozzles, and control rod drive return nozzles were not included in the licensee's request.

Examination Category

B-D, "Full Penetration Welded Nozzles in Vessels" - Inspection Program B

Examination Item Number

B3.90, "Nozzle-to-Vessel Welds" and B3.100, "Nozzle Inside Radius Section"

ASME Code Requirement for which Alternative is Requested (as stated)

The 2004 Edition [(The applicable ISI Code of Record for the fourth 10-year ISI interval for BFN, Unit 2)] of ASME [Code,] Section XI, Table IWB-2500-1, Examination Category B-D, Item No. B3.90 and Item No. B3.100, require a volumetric examination of 100 percent each ten-year inspection interval of the [RPV] nozzle-to-shell welds and nozzle inner radius section.

Licensee's Proposed Alternative to the ASME Code (as stated)

Pursuant to 10 CFR 50.55a(a)(3)(i), TVA is requesting relief from performing the required examinations on 100 percent of the identified nozzles. As an alternative, TVA proposes to examine 25 percent of the nozzle-to-vessel welds and nozzle inner radius sections, except for the Recirculation Outlet welds, including at least one nozzle from each system and nominal pipe size in accordance with ASME Code Case N-702. For the nozzles identified in Attachment A,[1] the number of components to be examined from each group is provided in Table 1[2] below. This relief is not requested to be applied to the Recirculation Outlet Nozzle welds.

[ASME] Code Case N-702 states that a VT-1 visual examination may be used in lieu of volumetric examination for the inner radii (Item B3.100). TVA is currently using [ASME] Code Case N-648-1, Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles, Section XI Division 1, subject to the conditions provided in Regulatory Guide [(RG)] 1.147, Revision 15, ["Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1,"] dated October 2007.

Licensee's Bases for Alternative (as stated)

...In Section 5.0, "Plant Specific Applicability," of the [SE for the BWRVIP-108 report], the NRC stated that each licensee who plans to request relief from the ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radius sections may reference the BWRVIP-108 report as the technical basis for the use of ASME Code Case N-702 as an alternative. However, each licensee should demonstrate the plant-specific applicability for the BWRVIP-108 report to each unit in the relief request by showing that all the general and nozzle-specific criteria addressed below are satisfied (See Attachment B[3]):

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[1] This refers to Attachment A to Attachment 11 of the licensee's March 31, 2010, submittal. Attachment A is not included in this SE.

[2] This refers to Table 1 in Attachment 11 to the licensee's March 31, 2010, submittal. Table 1 is not included in this SE.

[3] This refers to Attachment B to Attachment 11 of the licensee's March 31, 2010, submittal. Attachment B is not included in this SE.

Criterion 1: the maximum RPV heatup/cooldown rate is less than 115° F/hour,

(1) ...The BFN, Unit 2 Technical Specifications (TS) Surveillance Requirement (SR) 3.4.9.1.b limits Reactor Coolant System (RCS) heatup and cooldown rates to ≤ 100 °F in any 1 hour for pressure and temperature limits specified in TS Figure 3.4.9-1, "Pressure/Temperature Limits for Mechanical Heatup, Cooldown following Shutdown, and Reactor Critical Operations." For the pressure and temperature limits specified in TS Figure 3.4.9-2, "Pressure/Temperature Limits for In-Service Leak and Hydrostatic Testing," Note 2 to BFN, Unit 2 TS SR 3.4.9.1 limits RCS heatup and cooldown rates to ≤ 15 °F/hour.

Criteria 2 and 3: for recirculation inlet nozzles,

(2) $(pr/t)/C_{RPV} < 1.15$; the calculation for BFN[, Unit 2] Recirculation Inlet (N2) Nozzles results in 1.0986 which is less than 1.15 which satisfies Criterion 2.

(3) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$, the calculation for BFN[, Unit 2] N2 Nozzles results in 1.0012 which is less than 1.15 which satisfies Criterion 3.

Criteria 4 and 5: for recirculation outlet nozzles,

(4) $(pr/t)/C_{RPV} < 1.15$, the calculation for BFN[, Unit 2] Recirculation Outlet (N1) Nozzles results in 1.3134 which is higher than 1.15. Therefore, Criterion 4 is not satisfied for the BFN[, Unit 2] N1 Nozzles. Therefore, these nozzles are not in the scope of this relief request.

(5) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$, the calculation for the BFN[, Unit 2] N1 Nozzles results in 1.0751 which is less than 1.15 which satisfies Criterion 5.

Based upon the above information, all RPV nozzle-to-vessel shell welds and nozzle inner radii sections, with the exception of the Recirculation Outlet Nozzles, meet the BWRVIP-108 Report criteria and therefore [ASME] Code Case N-702 is applicable.

Period of application

[BFN] Unit 2, Fourth 10-Year [Inservice] Inspection [I]nterval (May 25, 2011 through May 24, 2021).

3.2 Staff Evaluation

The December 19, 2007, SE for the BWRVIP-108 report specified five plant-specific criteria that licensees must meet to demonstrate that the BWRVIP-108 report results apply to their plants. The five criteria are related to the driving force of the PFM analyses for the recirculation inlet and outlet nozzles. It was stated in the December 19, 2007, SE that the nozzle material fracture toughness-related reference temperature used in the PFM analyses were based on data from the entire fleet of BWR RPVs. Therefore, the BWRVIP-108 report PFM analyses are bounding with respect to fracture resistance, and only the driving force of the underlying PFM analyses needs to be evaluated. It was also stated in the December 19, 2007, SE that, except for the

RPV heatup/cooldown rate, the plant-specific criteria are for the recirculation inlet and outlet nozzles only because the probabilities of failure, P(F|E)s, for other nozzles are an order of magnitude lower. The plant-specific heatup/cooldown rate that the staff established in Criterion 1 regards the rate under the plant's normal operating condition, which is limiting. Events with excursions of heatup/cooldown rates exceeding 115° F/hour are considered transients. According to the December 19, 2007, SE, the PFM results with a very severe low temperature overpressure transient is not limiting, largely because the event frequency for that transient is $1x10^{-3}$ as opposed to 1.0 for the normal operating condition.

The licensee provided in the submittal TVA's plant-specific data for the BFN, Unit 2 RPV and its evaluation of the five driving force factors, or ratios, against the criteria established in the December 19, 2007, SE. The staff verified the licensee's evaluation, which indicated that, except for the fourth criterion (related to recirculation outlet nozzles), all other criteria are satisfied. As a result, the reduced inspection requirements in accordance with ASME Code Case N-702 do not apply to BFN, Unit 2 RPV recirculation outlet nozzles. The NRC staff agrees with the licensee's decision to exclude the recirculation outlet nozzles from the scope of this request based upon the licensee's evaluation. Considering that the driving force factor for the recirculation outlet nozzles (1.3134) is only moderately higher than the plant-specific criterion (1.15) and the P(F|E)s for other RPV nozzles are an order of magnitude lower than the recirculation outlet nozzles, the NRC staff concluded that the licensee's proposed alternative for all BFN, Unit 2 RPV nozzles included in this application (see Section 3.1 of this SE) provides an acceptable level of quality and safety.

It should be noted that RPV feedwater nozzles and control rod drive return line nozzles are outside the scope of ASME Code Case N-702 and are, accordingly, outside the scope of this application.

Additionally, ASME Code Case N-702 permits a VT-1 visual examination of the nozzle inner radius without performing a sensitivity demonstration of detecting a 1-mil width wire or crack. This provision is not consistent with the NRC position established in RG 1.147, Revision 15, regarding ASME Code Case N-648-1, which states, in part, "In place of a [ultrasonic testing] UT examination, licensees may perform a visual examination with enhanced magnification that has a resolution sensitivity to detect a 1-mil width wire or crack..." However, TVA's proposed alternative states that it currently uses ASME Code Case N-648-1, subject to the conditions provided in RG 1.147, Revision 15, for examinations of all nozzle inner radii. Therefore, the NRC staff concludes that the licensee's proposed alternative, which includes the use of ASME Code Case N-648-1, is consistent with the NRC position regarding VT-1 examinations in RG 1.147, Revision 15.

4.0 CONCLUSION

The NRC staff has reviewed the submittal regarding the licensee's evaluation of the five plant-specific criteria specified in the December 19, 2007, SE for the BWRVIP-108 report, which provides technical bases for use of ASME Code Case N-702, to examine RPV nozzle-to-vessel welds and nozzle inner radii at BFN, Unit 2. Based on the evaluation in Section 3.2 of this SE, the NRC staff determined that the licensee's proposed alternative provides an acceptable level of quality and safety and applies to all requested BFN, Unit 2 RPV nozzles, with the exception of the recirculation outlet nozzles, feedwater nozzles, and control rod drive return nozzles. The NRC staff also finds the licensee's adoption of ASME Code Case N-648-1 consistent with the

NRC position stipulated in R.G. 1.147 provides reasonable assurance of structural integrity of the nozzles' inner radii.

Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i) and is in compliance with the ASME Codes' requirements. Therefore, the NRC authorizes the licensee's proposed alternative for inspection of the RPV nozzle-to-vessel shell welds and nozzle inner radii sections listed in Attachment A of Attachment 11 of the licensee's March 31, 2010, submittal for BFN, Unit 2 through the end of the fourth 10-year ISI interval, which ends on May 24, 2021.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Simon Sheng

Date: March 24, 2011

If you have any questions regarding this matter, please contact Christopher Gratton at (301) 415-1055.

Sincerely,

/RA/

Douglas A. Broaddus, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-260

Enclosure: Safety Evaluation

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