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

March 30, 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-PDI-40, FOR THE FOURTH 10-YEAR INSERVICE INPSECTION INTERVAL (TAC NO. ME3719)

Dear Mr. Krich:

By letter dated March 31, 2010, (Agencywide Documents Access and Management System Accession No. ML100920542), Tennessee Valley Authority (the licensee), submitted a relief request (RR) 2-PDI-40 to the Nuclear Regulatory Commission (NRC) for the use of an alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI inspection requirements regarding examination of the reactor pressure vessel (RPV) circumferential shell-to-flange weld and the RPV closure head-to-flange weld at Browns Ferry Nuclear Plant (BFN), Unit 2. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.55a(a)(3)(i), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety.

In lieu of ASME Code, Section V, Article 4 methods, the licensee proposed to use the techniques, personnel, and equipment qualified to meet the requirements of ASME Code, Section XI, Appendix VIII, Supplements 4 and 6 of the 2001 Edition, by following the Electric Power Research Institute's performance demonstration initiative (PDI) processes for ultrasonic examination. The PDI examinations are more sensitive for detecting flaws than ASME Code, Section V, Article 4 methods because the examination sensitivity levels, detailed procedure criteria, and blind demonstrations enhance and verify their effectiveness. As such, the PDI-qualified procedures provide a higher probability of detection than ASME Code, Section V, Article 4 methods, which are based on amplitude thresholds determined via calibration blocks with machined reflectors.

Based on our review, the NRC staff determines that the licensee's proposed alternative contained in RR 2-PDI-40 provides an acceptable level of quality and safety. 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 Code's requirements.

This relief is authorized, in accordance with 10 CFR 50.55a(a)(3)(i), for the fourth 10-year inservice inspection interval at BFN Unit 2, which begins May 25, 2011, and ends May 24, 2021.

Sincerely,

/Douglas A Broaddus/

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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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM

REQUEST FOR RELIEF NO. 2-PDI-40

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-260

1.0 INTRODUCTION

By letter to the Nuclear Regulatory Commission (NRC, the Commission) dated March 31, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100920542), Tennessee Valley Authority (TVA), licensee for Browns Ferry Nuclear Plant (BFN), Unit 2, submitted a proposed alternative under Request for Relief (RR) 2-PDI-40, in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50.55a, paragraph (a)(3)(i). In RR 2-PDI-40, the licensee requested NRC approval of a proposed alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI inspection requirements regarding examination of the reactor pressure vessel (RPV) circumferential shell-to-flange weld and the RPV closure head-to-flange weld.

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 required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) of 10 CFR states that alternatives to the requirements of paragraph (g) may be used, when authorized by the 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.

The regulations at 10 CFR 50.55a(g)(4) further state that ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and preservice examination requirements, set forth in the ASME Code, Section XI to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable ISI Code of

Record for the fourth 10-year ISI interval for BFN, Unit 2 is the 2004 Edition with no Addenda of the ASME Code, Section XI.

In addition, for ultrasonic (UT) examinations, the licensee will follow the Electric Power Research Institute's (EPRI's) "Performance Demonstration for Ultrasonic Examination Systems," implementation of the 2001 Edition of ASME Code, Section XI, Appendix VIII in accordance with the requirements of 10 CFR 50.55a(b)(2)(xv), as amended by 10 CFR 50.55a(b)(2)(xv)(B) through 10 CFR 50.55a(b)(2)(xv)(G) and 10 CFR 50.55a(b)(2)(xvi)(A).

3.0 LICENSEE EVALUATION

Request for Relief 2-PDI-40, ASME Code, Section XI, Examination Category B-A, Items B1.30, and B1.40 Pressure Retaining Welds in RPV

System/Component

RPV Upper Vessel Shell-to-Flange Weld No. C-5-FLG

RPV Upper Head-to-Flange Weld No. RCH-2-2C

ASME Code Class

ASME Code Class 1

ASME Code Requirement

ASME Code, Section XI, Examination Category B-A, Items B1.30 and B1.40 require essentially 100 percent volumetric examination, as defined by ASME Code, Figures IWB-2500-4, and IWB-2500-5, of the length of RPV Shell-to-Flange Weld No. C-5-FLG and Upper Head-to-Flange Weld No. RCH-2-2C, respectively. In addition, ASME Code, Section XI, Examination Category B-A, Item 1.40 requires a surface examination for Upper Head-to-Flange Weld No. RCH-2-2C. An examination of "essentially 100 percent" of a defined examination volume or area, as clarified by ASME Code Case N-460, "Alternative Examination Coverage for Class 1 and Class 2 Welds," is greater than 90 percent coverage of the examination volume, or surface area, as applicable. ASME Code Case N-460 has been approved for use by the NRC in Regulatory Guide 1.147, Revision 15, "Inservice Inspection Code Case Acceptability."

Further, the primary requirements for application of all UT examinations can be found in ASME Code, Section XI, Appendix I, which excludes RPV shell-to-flange welds and upper head-to-flange welds greater than 2 inches in thickness from the requirement of being examined by procedures, equipment, and personnel that have been qualified by performance demonstration in accordance with ASME Code, Section XI, Appendix VIII. These welds are specified to be examined in accordance with the applicable requirements of ASME Code, Section V, Article 4 as supplemented by Table I-2000-1.

Licensee's ASME Code Relief Request (as stated)

> Pursuant to 10 CFR 50.55a(a)(3)(i), TVA requests relief from performing the designated vessel shell-to-flange weld and head-to-shell weld examinations in accordance with the requirements of ASME [Code,] Section XI, Paragraph IWA-2232, Appendix I, and the associated of Section V, Article 4 methodology in accordance with Paragraph I-2110(b).

Licensee's Proposed Alternative Examination (as stated)

> TVA proposes the following alternative examination. In lieu of the requirements of [ASME Code, Section XI,] Appendix I and its associated sub-requirements of [ASME Code, Section V,] Article 4, TVA will use the techniques, personnel, and equipment qualified to meet the requirements of ASME [Code,] Section XI, Appendix VIII, Supplements 4 and 6 of the 2001 Edition, in accordance with 10 CFR 50.55a(b)(2)(xv) and, as amended by 10 CFR 50.55a(b)(2)(xv)(B) through 10 CFR 50.55a(b)(2)(xv)(G) and 10 CFR 50.55a(b)(2)(xvi)(A), by following the [EPRI PDI] processes.

Licensee's Basis for Relief Request and Proposed Alternative (as stated)

> In accordance with ASME [Code,] Section XI, Subarticle IWA-2232, TVA is required to perform ultrasonic examinations (UT) of the RPV upper shell-to-flange and head-to-flange welds using [ASME Code,] Section XI, Appendix I, which in turn requires the use of the NDE [non-destructive examination] methodologies and processes of ASME [Code,] Section V, Article 4,
>
> The above listed welds are the only circumferential shell welds in the RPV that are not examined in accordance with the requirements of ASME [Code,] Section XI, Appendix VIII as mandated in 10 CFR 50.55a with the issuance of the rule change dated September 22, 2009 (*Federal Register* Notice 64 FR 51370). This rule change mandated the use of ASME [Code,] Section XI, Appendix VIII, Supplements 4 and 6 for the conduct of RPV examinations. Requests for relief are required to use the more technically-advanced [ASME Code, Section XI,] Appendix VIII/PDI [Performance Demonstration Initiative] processes for the shell-to-flange weld exams and the closure head-to-flange weld exams, in lieu of the [ASME Code,] Section XI, Appendix I and its associated [ASME Code,] Section V, Article 4 processes.
>
> ASME [Code,] Section V, Article 4, describes the required techniques to be used for the Ultrasonic Test (UT) of welds in ferritic pressure vessels with wall thicknesses greater than 2 inches. The techniques were first published in ASME [Code,] Section V in the 1974 Edition, summer 1975 Addenda. The calibration techniques, recording criteria and flaw sizing methods are based upon the use of a distance-amplitude-correction (DAC) curve derived from machined reflectors in a basic calibration block. UT performed in accordance with [ASME Code,] Section V, Article 4, used recording thresholds of 50 percent DAC for the outer 80 percent of the required examination volume and 20 percent DAC from the clad/base metal interface to the inner 20 percent margin of the examination

volume. Indications detected in the designated exam volume portions, with amplitudes below these thresholds, were therefore not required to be recorded. Use of the [ASME Code, Section XI,] Appendix VIII/PDI processes would enhance the quality of the examination results reported because the detection sensitivity is more conservative and the procedure requires the examiner to evaluate all indications determined to be flaws regardless of their associated amplitude. The recording thresholds in [ASME Code,] Section V, Article 4, requirements and in the previously-applied guidelines of RG [Regulatory Guide] - 1.150, Revision 1 ["Ultrasonic Testing of Reactor Vessel Welds During Preservice And Inservice Examinations"], are generic and somewhat arbitrary and do not take into consideration such factors as flaw orientation, which can influence the amplitude of UT responses.

The EPRI Report NP-6273, "Accuracy of Ultrasonic Flaw Sizing Techniques for Reactor Pressure Vessels," dated March 1989, established that UT flaw sizing techniques based on tip diffraction are the most accurate. The qualified prescriptive-based UT procedures of ASME [Code,] Section V, Article 4 have been applied in a controlled process with mockups of RPVs which contained real flaws and the results statistically analyzed according to the screening criteria in Appendix VIII of ASME [Code] Section XI. The results show that the procedures in [ASME Code,] Section V, Article 4, are less effective in detecting flaws than procedures qualified in accordance with [ASME Code, Section XI,] Appendix VIII as administered by the PDI processes. [ASME Code, Section XI,] Appendix VIII/PDI qualification procedures use the tip diffraction techniques for flaw sizing. The proposed alternative [ASME Code, Section XI,] Appendix VIII/PDI UT methodology uses analysis tools based upon echo dynamic motion and tip diffraction criteria which has been validated, and is considered more accurate than the [ASME Code,] Section V, Article 4 processes.

UT performed in accordance with the [ASME Code,] Section V, Article 4 processes requires the use of beam angles of 0° [degrees], 45°, 60°, and 70° with recording criteria that precipitates equipment changes. Having to perform these process changes is time consuming and results in increased radiation exposure for the examination personnel.

Having to comply with the specific ASME [Code,] Section XI, Appendix I requirements for the RPV circumferential shell-to-flange weld and the head-to-flange weld, when the data is obtained using a less technically advanced process, results in an examination that does not provide a compensating increase in quality and safety for the higher costs and personnel exposures involved.

Past RPV shell-to-flange weld and head-to-flange weld examinations already performed at TVA plants used automated and manual UT systems operated by qualified vendors.

The examination coverage achieved during the [BFN] Unit 2, 2001 exam (Cycle 11 outage, 04/03/2001) of the shell-to-flange weld (during the 2nd ISI program interval) resulted in a coverage of approximately 76.6 percent which is

less than the required essentially 100 percent. Manual examination techniques were performed from the outside surfaces of the RPV during the [BFN,] Unit 2 examination in order to maximize the coverage. Examination coverage performed from the inside surfaces was limited due to the taper in the vessel wall at the edge of the weld area and the obstructions encountered with the guide rods and the steam nozzle plugs with the specific UT equipment used during the exam. The manual examination of the weld volume performed from the outside surfaces was limited by the flange configuration. This limited exam with a percentage of coverage of less than 90 percent was the subject of a BFN, Unit 2 relief request number RR 2-ISI-14. This relief was reviewed by the NRC and found to be acceptable [based on 10 CFR 50.55a(a)(3)(i)]. A safety evaluation report (SER), on this relief, was issued by the NRC in a letter to J. A. Scalice, from A. G. Howe, dated April 3, 2003 (ADAMS Accession Number ML030970815). The examination performed on the [BFN] Unit 3 RPV used a different set of newer designed UT equipment and thereby achieved a calculated coverage of 95 percent. Therefore, the [BFN] Unit 3 examination results did not require the submittal and review of a relief request.

For future [BFN] Unit 2 RPV shell-to-flange weld examinations and closure head-to-flange weld examinations, TVA does not anticipate any less coverage than the required minimum of 90 percent of coverage. However, if any such limitations are encountered during the conduct of the examinations, a separate individual relief request will be submitted, as needed.

Procedures, equipment, and personnel qualified through the [ASME Code, Section XI,] Appendix VIII, Supplements 4 and 6 PDI programs have shown to have a high probability of detection of flaws and are generally considered superior to the techniques employed earlier for RPV examinations. This results in increased reliability of RPV inspections and conditions where an acceptable level of quality and safety is provided with the proposed alternative methodologies. Accordingly, approval of this alternative evaluation process is requested pursuant to 10 CFR 50.55a(a)(3)(i).

4.0 STAFF EVALUATION

The ASME Code requires that prescriptive UT requirements found in ASME Code, Section V, Article 4 be employed for examining RPV Shell-to-Flange Weld No. C-5-FLG and Upper Head-to-Flange Weld No. RCH-2-2C, respectively. As an alternative to those prescriptive requirements, the licensee has proposed to use the techniques, personnel, and equipment qualified to meet the requirements of ASME Code, Section XI, Appendix VIII, Supplements 4 and 6 of the 2001 Edition, in accordance with 10 CFR 50.55a(b)(2)(xv), as amended by 10 CFR 50.55a(b)(2)(xv)(B) through 10 CFR 50.55a(b)(2)(xv)(G), and 10 CFR 50.55a(b)(2)(xvi)(A), by following the EPRI PDI processes.

UT performance-based techniques are based on the ability of personnel, procedures and equipment to detect and characterize simulated flaws in specimens that are typical of components found in the field. These methods are required by 10 CFR 50.55a for RPV shell and head welds, piping welds, dissimilar metal welds and bolting. The NRC staff has reviewed and evaluated TVA's alternative to use a UT technique (personnel, equipment, and procedures)

qualified to Appendix VIII, Supplements 4 and 6. The Appendix VIII criteria were developed to ensure the effectiveness of UT examinations within the nuclear industry by means of a rigorous, item specific performance demonstration. The performance demonstration is conducted on RPV mockup containing flaws of various sizes and locations. The demonstration establishes the capability of equipment, procedures, and personnel to find flaws that could be detrimental to the integrity of the RPV. Qualification under the performance demonstration initiative shows that a UT technique is equal to or surpasses the requirements of the ASME Code, Section V, Article 4 methods, which are based on amplitude thresholds determined via calibration blocks with machined reflectors. The performance demonstration examinations are more sensitive for detecting flaws than ASME Code, Section V, Article 4 methods because the examination sensitivity levels, detailed procedure criteria, and blind demonstrations enhance and verify their effectiveness. As such, the PDI-qualified procedures provide a higher probability of detection than prescriptive-based methods.

Therefore, based on the enhanced properties of UT techniques qualified through ASME Code, Section XI, Appendix VIII requirements, the NRC staff has determined that the licensee's proposed alternative provides an acceptable level of quality and safety.

5.0 CONCLUSION

Based on our review, the NRC staff determines that the licensee's proposed alternative contained in RR 2-PDI-40 provides an acceptable level of quality and safety. 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 Code's requirements. Therefore, the NRC staff authorizes the licensee-proposed alternative at BFN, Unit 2 for the fourth ISI interval, which ends May 24, 2021.

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

Principle Contributor: T. McLellan

Date: March 30, 2011

Based on our review, the NRC staff determines that the licensee's proposed alternative contained in RR 2-PDI-40 provides an acceptable level of quality and safety. 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 Code's requirements.

This relief is authorized, in accordance with 10 CFR 50.55a(a)(3)(i), for the fourth 10-year inservice inspection interval at BFN Unit 2, which begins May 25, 2011, and ends May 24, 2021.

Sincerely,

/RA/

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

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