

August 2, 2005

Mr. Karl W. Singer
Chief Nuclear Officer and
Executive Vice President
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6A Lookout Place
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SUBJECT: BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3, SEQUOYAH
NUCLEAR PLANT UNITS 1 AND 2, AND WATTS BAR NUCLEAR PLANT
UNIT 1 - INSERVICE INSPECTION PROGRAM RELIEF REQUEST PDI-4
(TAC NOS. MC6232, MC6233, MC6234, MC6235, MC6236 AND MC6237)

Dear Mr. Singer:

By letter dated February 23, 2005, the Tennessee Valley Authority (TVA) submitted a request for relief from the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI for the Reactor Pressure Vessel (RPV) circumferential shell-to-flange welds under Tile 10, *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i) for the Browns Ferry Nuclear Plant, Units 1, 2, and 3; Sequoyah Nuclear Plant, Units 1 and 2; and Watts Bar Nuclear Plant, Unit 1. The request applies to the subject units during their current 10-year Inservice Inspection (ISI) intervals and also includes examinations performed at Browns Ferry Nuclear Plant, Unit 2, during its last (second) 10-year ISI interval. The request proposed that in lieu of the requirements of the ASME Code, Section XI, Subarticle IWA-2232 and its referenced Section V, Article 4 requirements, the procedures, personnel, and equipment qualified to meet the requirements of ASME Section XI Appendix VIII, Supplements 4 and 6 of the 1995 Edition through the 1996 Addenda, as administered by the Electric Power Research Institute's (EPRI's) Performance Demonstration Initiative (PDI) processes be used to conduct the required vessel-to-flange weld examinations at the subject units.

The U.S. Nuclear Regulatory Commission staff has completed its review of the information provided in TVA's February 23, 2005 letter. The staff concluded that the proposed alternative to the requirements of Section XI, paragraph IWA-2232 of the ASME Code described in the licensee's letter provides an acceptable level of quality and safety. Therefore, Request for Relief PDI-4, Revision 1, is authorized pursuant to 10 CFR 50.55a(a)(3)(i) for Browns Ferry Nuclear Plant, Units 1, 2, and 3; Sequoyah Nuclear Plant, Units 1 and 2; and Watts Bar Nuclear Plant, Unit 1, for ASME Section XI, Class 1, RPV-to-flange weld examinations in their current 10-year ISI interval and examinations performed during the second 10-year ISI interval at Browns Ferry Nuclear Plant, Unit 2. All other requirements of the ASME Code, Section XI for

Mr. Karl Singer

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which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

The staff's evaluation and conclusions are contained in the staff's safety evaluation provided in the Enclosure.

Sincerely,

/RA/

Michael L. Marshall, Jr., Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, 50-296,
50-327, 50-328 and 50-390

Enclosure: Safety Evaluation

cc w/enclosure: See next page

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Enclosure: Safety Evaluation

cc w/enclosure: See next page

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*No Legal Objection

NRR-028

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM RELIEF REQUEST

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2 AND 3

SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2

WATTS BAR NUCLEAR PLANT, UNIT 1

TENNESSEE VALLEY AUTHORITY

DOCKET NOS. 50-259, 50-260, 50-296, 50-327, 50-328 AND 50-390

1.0 INTRODUCTION

By letter dated February 23, 2005, Tennessee Valley Authority (TVA, the licensee) requested relief under Relief Request PDI-4 for Browns Ferry Nuclear Plant, Units 1, 2 and 3 (BFN-1, BFN-2, and BFN-3); Sequoyah Nuclear Plant, Units 1 and 2, (SQN-1 and SQN-2); and Watts Bar Nuclear Plant, Unit 1 (WBN-1), from certain examination requirements in the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) for Class 1, Examination Category B-A, pressure-retaining welds in the reactor vessel. The licensee proposed one alternative in lieu of the applicable requirements. This relief request applies to the above referenced units during their current 10-year Inservice Inspection (ISI) intervals and also includes examinations performed at BFN-2 during its last (second) 10-year ISI interval.

2.0 REGULATORY EVALUATION

The ISI of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI, "*Rules for Inservice Inspection of Nuclear Power Plant Components*," and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g), except when specific relief has been granted by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). It states, in part, in 10 CFR 50.55a(a)(3) that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the applicant demonstrates that: (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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, to the extent

Enclosure

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 record, interval and interval dates are shown below in section 3.2

3.0 TECHNICAL EVALUATION

3.1 System/Components for which Relief is Requested

This relief request applies to the ASME Code, Section XI, Class 1, Examination Category B-A, Item No. B1.30 welds identified below:

BFN: Unit 1 - TVA ISI Program Weld Designation 1-C-5-FLG
 Unit 2 - TVA ISI Program Weld Designation 2-C-5-FLG
 Unit 3 - TVA ISI Program Weld Designation 3-C-5-FLG

SQN: Unit 1 - TVA ISI Program Weld Designation 1-W06-07
 Unit 2 - TVA ISI Program Weld Designation 2-W06-07

WBN: Unit 1 - TVA ISI Program Weld Designation W06-07

3.2 Code Requirements for which Relief is Requested

The applicable Code of record for each unit is detailed below:

Facility	Applicable Code of record	Interval	ISI interval
BFN-1	1995 Edition with the 1996* Addenda (re-baseline exams)	First*	12/16/75 to one year after restart Currently scheduled for May 2007*
BFN-2	1995 Edition with the 1996 Addenda	Third	05/25/01 to 05/24/11
BFN-3	1989 Edition, No Addenda	Second	11/19/96 to 11/18/05
SQN-1	1989 Edition, No Addenda	Second	12/16/95 to 05/31/06
SQN-2	1989 Edition, No Addenda	Second	12/16/95 to 05/31/06
WBN-1	1989 Edition, No Addenda	First	05/27/96 to 12/26/06

* BFN-1 has been shut down since 1985. As part of the restart effort, the licensee is performing a re-baseline examination of the reactor pressure vessel shell-to-flange weld. Re-baseline examinations will be performed in accordance with the 1995 Edition with the 1996 Addenda of ASME Section XI.

The 1989 Edition, No Addenda and the 1995 Edition with the 1996 Addenda of the ASME Code, Section XI, specify the examination requirements for the reactor pressure vessel (RPV)

upper shell-to-flange welds. IWA-2232 requires ultrasonic examinations to be conducted in accordance with Appendix I, which makes reference to the ASME Code, Section V, Article 4. Pursuant to 10 CFR 50.55a(a)(3)(i), TVA requests relief from performing the designated vessel shell-to-flange weld examination in accordance with the requirements of ASME Section XI, paragraph IWA-2232, Appendix I, and associated Article 4 of Section V methodology in accordance with paragraph I-2110(b).

3.3 Proposed Alternative and Basis for Use

In lieu of the requirements of the ASME Code, Section XI, Subarticle IWA-2232 and its referenced Section V, Article 4 requirements, TVA proposes to use procedures, personnel, and equipment qualified to meet the requirements of ASME Section XI Appendix VIII, Supplements 4 and 6 of the 1995 Edition through the 1996 Addenda, as administered by the Electric Power Research Institute's (EPRI's) Performance Demonstration Initiative (PDI) processes to conduct the vessel-to-flange weld examinations at BFN-1, BFN-2, BFN-3, SQN-1, SQN-2, and WBN-1.

In accordance with ASME Section XI, Subarticle IWA-2232, TVA is required to perform ultrasonic examinations (UT) of the RPV upper shell-to-flange welds (at the indicated plants and units) using Section XI, Appendix I, which in turn requires the use of the NDE [nondestructive examination] methodologies and processes of ASME Section V, Article 4. In addition, the guidance of RG [Regulatory Guide] 1.150, Revision 1, was historically applied. The above listed welds are the only circumferential shell welds in the RPVs that are not examined in accordance with the requirements of ASME Section XI, Appendix VIII, as mandated in 10 CFR 50.55a with the issuance of the rule change shown in the *Federal Register* Notice 64 FR 51370, dated September 22, 1999. This rule change mandated the use of ASME Section XI, Appendix VIII, Supplements 4 and 6 for the conduct of RPV examinations. It has been recently stated in EPRI PDI coordination meetings between the PDI committee members and the NRC Staff representatives that the NRC Staff expectations are that licensees should submit requests for relief to use the more technically advanced Appendix VIII/PDI processes for the shell-to-flange weld exams, in lieu of the Section XI Appendix I and its associated Section V, Article 4 processes.

ASME Section V, Article 4, describes the required techniques to be used for the UT of welds in ferretic pressure vessels with wall thicknesses greater than 2 inches. The techniques were first published in ASME 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 curve (DAC) derived from machined reflectors in a basic calibration-block. UT performed in accordance with 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 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 Section V, Article 4, requirements and in the guidelines of RG-1.150, Revision 1, 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 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 Section XI. The results show that the procedures in Section V, Article 4, are less effective in detecting flaws than procedures qualified in accordance with Appendix VIII as administered by the PDI processes. Appendix VIII/PDI qualification procedures use the tip diffraction techniques for flaw sizing. The proposed alternative 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 Section V, Article 4 processes.

UT performed in accordance with the Section V, Article 4 processes requires the use of beam angles of 0°, 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 Section XI, Appendix I requirements for the RPV circumferential shell-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 examinations already performed at TVA plants and units (i.e., for BFN Units 2 and 3) used automated and manual UT systems operated by qualified vendors. The examination coverage achieved during the 2001 exam of the Unit 2 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 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. A safety evaluation report (SER) on this relief was issued by the NRC in a letter to J. A. Scalice, from Allen G. Howe, dated April 3, 2003, [see TAC Nos. MB5309, MB8130, MB8132, and MB8133 (ML030970815)]. Therefore, the

Unit 3 examination results did not require the submittal and review of a relief request.

For future RPV shell-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, separate individual relief requests will be submitted, as needed. Sketches of the basic RPV shell-to-flange weld configurations for the six units addressed by this request are attached for information and use with this requested review and are shown as Figure 1, for BFN Units 1, 2, and 3; Figure 2a for SQN Unit 1, Figure 2b for SQN Unit 2, and Figure 3 for WBN Unit 1 [Figures are shown in the licensee's submittal].

Procedures, equipment, and personnel qualified through the 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).

3.6 Evaluation

The 1989 Edition, No Addenda and the 1995 Edition through the 1996 Addenda, ASME Code, Section XI requires the examination of reactor pressure vessel upper vessel shell-to-flange welds to comply with Article 4 of the ASME Code, Section V, as stated in Subsection IWA-2232 of Section XI. The licensee proposes the use of procedures, personnel, and equipment qualified to meet the requirements of ASME Section XI Appendix VIII, Supplements 4 and 6 of the 1995 Edition through the 1996 Addenda, as administered by the EPRI's PDI processes to conduct the required vessel-to-flange weld examinations.

The request for relief pertains to inspections that have already been performed at BFN-2 during the second interval (last interval) Cycle 11 Outage (04/03/2001) and BFN-3 during the second interval (current interval) Cycle 11 Outage (03/15/2004) as well as future examinations that will be performed at SQN-1 Cycle 14 Outage, SQN-2 Cycle 13 Outage, WBN-1 Cycle 6 Outage, BFN-2 during its current interval and inspections to be performed as part of the BFN-1 re-baseline examinations. The licensee indicated that the BFN-2 examination obtained 76.6 percent coverage in lieu of the Code required 90 percent minimum for which the applicant requested and received relief from the NRC for its second interval examination. BFN-3 examinations obtained 95 percent coverage. The applicant estimates that coverage on BFN-1, SQN-1, SQN-2 and WBN-1 will be equal to or greater than 90 percent. If coverage is less than 90 percent for any examination performed under this relief request, the applicant will seek relief.

The 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 was 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 mockups 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 Code and the recommendations of RG 1.150. Therefore, the staff has determined that the alternative provides an acceptable level of quality and safety.

Pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative is authorized for the RPV-to-flange weld examination for BFN-2 second interval and BFN-3 second interval examinations that have already been performed and third interval BFN-2, second interval SQN-1, second interval SQN-2, first interval WBN-1 examinations as well as re-baseline examinations at BFN-1 that are scheduled to be performed in the future.

4.0 CONCLUSION

Based on our review, the NRC staff finds that the proposed alternative described in TVA's letter dated February 23, 2005, provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternative for BFN-1, BFN-2, BFN-3, SQN-1, SQN-2, and WBN-1, ASME Section XI, Class 1, RPV-to-flange weld examinations for their current 10-year ISI interval and examinations performed during the second 10-year ISI interval at BFN-2 as indicated in the licensee's submittal. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Robert Davis

Date: August 2, 2005