



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

October 18, 2016

Mr. Joseph W. Shea  
Vice President, Nuclear Licensing  
Tennessee Valley Authority  
1101 Market Street, LP 3R-C  
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – ALTERNATIVE TO  
INSERVICE INSPECTION REQUIREMENTS OF THE ASME BOILER AND  
PRESSURE VESSEL CODE FOR EXAMINATION OF REACTOR PRESSURE  
VESSEL SHELL-TO-FLANGE WELD (CAC NOS. MF7628 AND MF7629)

Dear Mr. Shea:

By letter dated April 22, 2016, (Agencywide Documents Access and Management System Accession No. ML16113A388), Tennessee Valley Authority (TVA, the licensee) submitted a Request for Alternative No. WBN-1 & 2/PDI-4, to the U.S. Nuclear Regulatory Commission (NRC) for the third 10-year inservice inspection (ISI) interval of Watts Bar Nuclear Plant (WBN), Unit 1 and the first 10-year ISI interval of WBN, Unit 2. In Request for Alternative No. WBN 1 & 2/PDI-4, TVA requested NRC approval of the volumetric examination techniques in Appendix VIII "Performance Demonstration for Ultrasonic Examination Systems" to Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to inspect the reactor pressure vessel (RPV) shell-to-flange weld in lieu of the requirements in Appendix I "Ultrasonic Examinations" to Section XI (and the associated Article 4 "Ultrasonic Examination Methods for Welds" of Section V) of the ASME Code.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), TVA requested to use an alternative examination of the RPV shell-to-flange weld on the basis that the alternative provides an acceptable level of quality and safety.

The NRC staff finds that the use of procedures qualified to the requirements of Appendix VIII, Supplement 4 and 6, to Section XI of the ASME Code, to inspect the RPV shell-to-flange welds W06-07 at WBN, Units 1 and 2, provides an acceptable level of quality and safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the staff authorizes Request for Alternative No. WBN-1 & 2/PDI-4 for the third 10-year ISI interval at WBN, Unit 1 and for the first 10-year ISI interval at WBN, Unit 2, which are scheduled to begin in 2016.

J. Shea

- 2 -

If you have any questions, please contact the project manager, Robert Schaaf, at 301-415-6020 or [Robert.Schaaf@nrc.gov](mailto:Robert.Schaaf@nrc.gov).

Sincerely,



Jeanne A. Dion, Acting Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-390 and 50-391

Enclosure:  
Safety Evaluation

cc w/encl: Distribution via ListServ



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ALTERNATIVE WBN-1 & 2/PDI-4 REGARDING VOLUMETRIC

EXAMINATION OF REACTOR PRESSURE VESSEL SHELL-TO-FLANGE WELD

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-390 AND 50-391

1.0 INTRODUCTION

By letter dated April 22, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16113A388), Tennessee Valley Authority (TVA, the licensee), submitted Request for Alternative No. WBN-1 & 2/PDI-4, to the U.S. Nuclear Regulatory Commission (NRC) for the third 10-year inservice inspection (ISI) interval of Watts Bar Nuclear Plant (WBN), Unit 1 and the first 10-year ISI interval of WBN, Unit 2. In Request for Alternative No. WBN-1 & 2/PDI-4, the licensee requested NRC approval of the volumetric examination techniques in Appendix VIII "Performance Demonstration for Ultrasonic Examination Systems" to Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to inspect the reactor pressure vessel (RPV) shell-to-flange weld in lieu of the requirements in Appendix I "Ultrasonic Examinations" to Section XI (and the associated Article 4 "Ultrasonic Examination Methods for Welds" of Section V) of the ASME Code. The RPV shell-to-flange weld is an ASME Code, Section XI, Examination Category B-A weld, Item No. B1.30.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.55a(z)(1), TVA proposed to use an alternative examination of the RPV shell-to-flange weld on the basis that the alternative provides an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

The ISI of ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the ASME Code and applicable edition and addenda, as required by 10 CFR 50.55a(g).

Enclosure

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall 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 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(a) 12 months prior to the start of the 120-month interval, subject to the conditions in 10 CFR 50.55a(b)(2).

It states, in part, in 10 CFR 50.55a(z), that alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC, if the applicant demonstrates that: (1) the proposed alternatives would provide an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The Code of Record for the WBN, Unit 1 third 10-year ISI interval and WBN, Unit 2 first 10-year ISI interval is the 2007 Edition of the ASME Code, Section XI with Addenda through 2008.

### 3.0 TECHNICAL EVALUATION

#### 3.1 The Licensee's Alternative

##### ASME Code Component Identification

ASME Code Class: ASME Code, Section XI, Class 1  
Examination Category: B-A, Pressure Retaining Welds in Reactor Vessel  
Item Number: B1.30  
Component: RPV shell-to-flange weld  
Weld Number: W06-07 (applicable to WBN, Units 1 and 2)

##### ASME Code Requirements

The required examination method for weld W06-07 is volumetric examination of the weld length, as specified in Table IWB-2500-1, "Examination Categories" of the ASME Code, Section XI, Examination Category B-A, Item No. B1.30. The volumetric examination shall be conducted by ultrasonic testing (UT) as specified in I-2110(b) of Appendix I to Section XI of the ASME Code, which states that the UT methods shall be in accordance with Article 4 of Section V of the ASME Code.

##### Proposed Alternative (as stated by the licensee)

In lieu of the requirements of ASME Section XI, Appendix I and Article 4 of ASME Section V, TVA will use the techniques, personnel, and equipment qualified to meet the requirements of ASME Section XI Appendix VIII, Supplements 4 and 6 of the 2007 Edition through the 2008 Addenda, as administered by the Electric Power Research Institute's (EPRI) Performance Demonstration Initiative (PDI) processes. This proposed alternative allows for the use of improved methodology in qualification of equipment and personnel performing ultrasonic examinations. This methodology uses an examination process that provides greater quality and

amount of coverage for the performance of the shell-to-flange weld examinations. Accordingly, the proposed alternative methodology provides an acceptable level of quality and safety. In addition, the proposed alternative results in lower personnel radiation exposure from not having to use a different methodology for the shell-to-flange weld.

Basis for Use (as stated by the licensee)

ASME Section V, Article 4, describes the required techniques to be used for the UT of RPV shell-to-flange welds, closure head-to-flange welds, and integral attachment welds and all other ferritic pressure vessels with wall thicknesses greater than two inches. 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. The 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 enhances 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 requirements in Section V, Article 4, are generic and somewhat arbitrary and do not take into consideration such factors as flaw orientation, which can influence the amplitude of UT responses.

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 that 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. The 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 that has been validated, and is more accurate than the Section V, Article 4 processes.

The 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 necessitates equipment changes. Performing these process changes is time consuming and results in increased radiation exposure for the examination personnel. Therefore, performing the ASME Section XI, Appendix I requirements for the RPV 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.

Procedures, equipment, and personnel qualified through the Appendix VIII, Supplements 4 and 6 PDI programs have shown to have a high probability of detecting flaws and are generally considered superior to the techniques employed earlier for RPV examinations, resulting in increased reliability of RPV inspections. Therefore, the proposed alternative methodologies

provide 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(z)(1).

### 3.2 NRC Staff Evaluation

The licensee proposed to use the examination requirements in Appendix VIII, Supplements 4 and 6, to Section XI of the ASME Code instead of those in Article 4 to Section V of the ASME Code for inspections by UT of the RPV shell-to-flange welds W06-07 of WBN, Units 1 and 2. The staff evaluated the proposed alternative examinations to determine if the use of the ASME Code, Section XI, Appendix VIII-qualified procedures has an acceptable level of quality and safety for the subject welds.

Procedures developed in accordance with Article 4 to Section V of the ASME Code are not required to be qualified or to be performance-based, while the use of rules in Appendix VIII to Section XI of the ASME Code to qualify UT procedures and personnel are performance-based. This difference has resulted in an improvement in the effectiveness of ISI of nuclear power plant components. The use of performance-based nondestructive examination methods provides confidence in the effectiveness and reliability of the examinations. The staff has supported the use of performance-based nondestructive examinations as evidenced by the various precedents of NRC approval of the use of Appendix VIII, Supplements 4 and 6, to Section XI of the ASME Code to inspect the RPV shell-to-flange welds listed in the licensee's submittal. This list includes the precedents for the previous (second) 10-year ISI interval of WBN, Unit 1 (ADAMS Accession No. ML080630679) and the preservice inspection program of WBN, Unit 2 (ADAMS Accession No. ML092300608). In addition, the NRC has approved the use of Appendix VIII, Supplements 4 and 6, to Section XI of the ASME Code to inspect weld W06-07 for the first 10-year ISI interval of WBN, Unit 1 (ADAMS Accession No. ML051730487).

The evaluations, procedures, equipment, and personnel qualified to Appendix VIII, Supplements 4 and 6, to Section XI of the ASME Code, have shown a high probability of flaw detection and have increased the reliability of examinations of weld configurations within the scope of the PDI program. Therefore, the staff has determined that using inspections qualified to Appendix VIII, Supplements 4 and 6, to Section XI of the ASME Code in lieu of the requirements in Article 4 to Section V of the ASME Code for the RPV shell-to-flange welds W06-07 at WBN, Units 1 and 2, provides an acceptable level of quality and safety.

### 4.0 CONCLUSION

As set forth above, the staff determined the use of procedures qualified to the requirements of Appendix VIII, Supplement 4 and 6, to Section XI of the ASME Code, to inspect the RPV shell-to-flange welds W06-07 at WBN, Units 1 and 2, provides an acceptable level of quality and safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the staff authorizes Request for Alternative No. WBN-1 & 2/PDI-4 for the third 10-year ISI interval at WBN, Unit 1 and for the first 10-year ISI interval at WBN, Unit 2, which are scheduled to begin in 2016.

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

Principal Contributor: David Dijamco

Date: October 18, 2016

J. Shea

- 2 -

If you have any questions, please contact the project manager, Robert Schaaf, at 301-415-6020 or [Robert.Schaaf@nrc.gov](mailto:Robert.Schaaf@nrc.gov).

Sincerely,

*/RA/*

Jeanne A. Dion, Acting Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-390 and 50-391

Enclosure:  
Safety Evaluation

cc w/encl: Distribution via ListServ

DISTRIBUTION:

PUBLIC  
LPL2-2 R/F  
RidsACRS\_MailCTR Resource  
RidsNrrDorLpl2-2 Resource  
RidsNrrEvib Resource  
RidsNrrLABClayton Resource  
RidsNrrPMWattsBar Resource  
RidsRgn2MailCenter Resource  
TClark, EDO  
DDijamco, NRR

**ADAMS Accession No. ML16239A072**

\*Safety Evaluation by e-mail

OFFICE	NRR/DORL/LPL2-2/PM	NRR/DORL/LPL2-2/LA	NRR/DE/EVIB*	NRR/DORL/LPL2-2/BC(A)
NAME	RSchaaf	BClayton	JMcHale	JDion
DATE	9/19/2016	9/20/2016	5/24/2016	10/18/2016

**OFFICIAL RECORD COPY**