



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

October 28, 2010

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, UNITS 1, 2, AND 3 - SAFETY
EVALUATION FOR RELIEF REQUEST ISI-23 (TAC NOS. ME3396, ME3397,
AND ME3398)

Dear Mr. Krich:

By letter dated January 15, 2010, the Tennessee Valley Authority (TVA) submitted a request to the Nuclear Regulatory Commission (NRC) for relief from certain requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, "Rules for Inservice Inspection [ISI] of Nuclear Power Plant Components," at the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55(a)(3)(i), TVA proposed to use ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," on the basis that the alternative provides an acceptable level of quality and safety.

The NRC staff reviewed TVA's request and concludes, as set forth in the enclosed safety evaluation (SE), that TVA has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(3)(i). Therefore, the proposed alternative is authorized for the second 10-year ISI interval for BFN Unit 1 and the third 10-year ISI interval for BFN Units 2 and 3. If you have any questions, please contact the plant project manager, Stewart Bailey, at 301-415-1321 or stewart.bailey@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Doug Broaddus".

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

Docket Nos. 50-259, 50-260, and 50-296

Enclosure:
Safety Evaluation

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

RELIEF REQUEST ISI-23

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

DOCKET NO. 50-259, 50-260, and 50-296

1.0 INTRODUCTION

By letter dated January 15, 2010, Tennessee Valley Authority (TVA), the licensee for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, submitted Relief Request ISI-23 to use an alternative to American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI inspection requirements regarding examination of certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii at BFN, Units 1, 2, and 3. The proposed alternative is in accordance with ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," without using the visual (VT-1) examination specified in the Code Case. The technical basis for ASME Code Case N-702 was documented in an Electric Power Research Institute (EPRI) report for the Boiling Water Reactor Vessel and Internals Project (BWRVIP), "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." The BWRVIP-108 report was approved by the U.S. Nuclear Regulatory Commission (NRC) in a safety evaluation (SE) dated December 19, 2007.

The December 19, 2007, SE for the BWRVIP-108 report specified plant-specific requirements that must be met for applicants proposing to use this alternative. TVA's January 15, 2010, submittal intended to demonstrate that the relevant BFN, Units 1, 2, and 3 RPV nozzle-to-vessel welds and their inner radii meet these plant-specific requirements so that Relief Request ISI-23 can be approved.

2.0 REGULATORY REQUIREMENTS

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 Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). It is stated in 10 CFR 50.55a(a)(3) 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.

Enclosure

It is further stated in 10 CFR 50.55a(g)(4) 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) twelve 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 BFN, Units 1 and 3 is the 2001 Edition through 2003 Addenda of ASME Code, Section XI, and the applicable ISI Code of Record for BFN, Unit 2 is the 1995 Edition through 1996 Addenda of ASME Code, Section XI.

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. As mentioned earlier, the NRC has approved the BWRVIP-108 report, which contains the technical basis supporting ASME Code Case N-702. The December 19, 2007, SE regarding the BWRVIP-108 report specified plant-specific requirements to be satisfied by applicants who propose to use ASME Code Case N-702.

3.0 EVALUATION

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:

However, 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/cool-down 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
 $C_{RPV} = 19332\dots$;

(3) $[p(r_o^2 + r_i^2) / (r_o^2 - r_i^2)] / C_{NOZZLE} < 1.15$

p = RPV normal operating pressure,
 r_o = nozzle outer radius,
 r_i = nozzle inner radius, and
 $C_{NOZZLE} = 1637\dots$;

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
 $C_{RPV} = 16171\dots$; and

(5) $[p(r_o^2 + r_i^2) / (r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$

p = RPV normal operating pressure,
 r_o = nozzle outer radius,
 r_i = nozzle inner radius, and
 $C_{NOZZLE} = 1977\dots$

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 RPVs of the licensee'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 are not included within the scope of this 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 2001 Edition, 2003 Addenda and 1995 Edition, 1996 Addenda, of ASME 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. For BFN Units 2 and 3, TVA is taking credit for nozzle-to-vessel welds and inner radius section examinations previously completed during the current ten-year interval for each unit. 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 EPRI 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]):

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

[1] This refers to Attachment A from the licensee's January 15, 2010, submittal. Attachment A is not included in this SE.

[2] This refers to Table 1 from the licensee's January 15, 2010, submittal. Table 1 is not included in this SE.

[3] This refers to Attachment B from the licensee's January 15, 2010, submittal. Attachment B is not included in this SE.

- (1) ... The BFN Units 1, 2, and 3 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 Units 1, 2, and 3, 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 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 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 Recirculation Outlet (N1) Nozzles results in 1.3134 which is higher than 1.15. Therefore, Criterion 4 is not satisfied for the BFN 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 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

Unit 1, Second Ten-Year Inspection interval (June 2, 2008 through June 1, 2017)

Unit 2, Third Ten-Year Inspection interval (May 25, 2001 through May 24, 2011)

Unit 3, Third Ten-Year Inspection interval (November 19, 2005 through November 18, 2015)

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 (RT_{NDT}) 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 as transients. According to the December 19, 2007, SE, the PFM results with a very severe low temperature overpressure (LTOP) transient is not limiting, largely because the event frequency for that transient is 1×10^{-3} as opposed to 1.0 for the normal operating condition.

The licensee provided in the submittal TVA's plant-specific data for BFN RPVs 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 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 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.

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 is not consistent with the NRC position established in RG 1.147 regarding ASME Code Case N-648-1. However, since the licensee's proposed alternative indicated that TVA is currently using ASME Code Case N-648-1, subject to the conditions provided in RG 1.147, Revision 15, for examinations of all nozzle inner radii, the inconsistency between ASME Code Case N-702 and the NRC position regarding VT-1 is not an issue in this application.

4.0 CONCLUSION

The 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, Units 1, 2, and 3. Based on the evaluation in Section 3.2 of this SE, the staff determined that the licensee's proposed alternative, pursuant to 10 CFR 50.55a(a)(3)(i), provides an acceptable level of quality and safety and applies to all requested BFN RPV nozzles. Therefore, the proposed alternative is authorized for the second 10-year ISI interval for BFN Unit 1 and the third 10-year ISI interval for BFN Units 2 and 3.

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: S. Sheng

Date: October 28, 2010

October 28, 2010

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, UNITS 1, 2, AND 3 - SAFETY
EVALUATION FOR RELIEF REQUEST ISI-23 (TAC NOS. ME3396, ME3397,
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Sincerely,

/RA/

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

Docket Nos. 50-259, 50-260, and 50-296

Enclosure:
Safety Evaluation

cc w/enclosure: Distribution via Listserv

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