August 3, 2006

Mr. Karl W. Singer
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 3 - REQUESTS FOR RELIEF 3-ISI-07, REVISION 1, 3-ISI-12, AND 3-ISI-19, FROM THE REQUIREMENTS OF THE ASME CODE ASSOCIATED WITH WELD EXAMINATION COVERAGE (TAC NOS. MC6314, MC6386 AND MC6387)

Dear Mr. Singer:

By a letter dated March 4, 2005, as supplemented by letters dated September 26, 2005, and May 4, 2006, the Tennessee Valley Authority (TVA, the licensee) submitted Relief Requests 3-ISI-07, Revision 1, 3-ISI-12, and 3-ISI-19, requesting relief from the examination coverage requirements specified in the American Society of Mechanical Engineers (ASME) Code, Section XI, for nozzle-to-vessel welds, full-penetration piping welds and reactor vessel pressure retaining welds at Browns Ferry Unit 3. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g)(5), TVA proposed to exclude those welds that are inaccessible for inspection.

Based on our review of the submittals, the U.S. Nuclear Regulatory Commission (NRC) staff concluded that the ASME Code examination coverage requirements are impractical for the subject welds listed in Relief Requests 3-ISI-7, Revision 1, 3-ISI-12, and 3-ISI-19. Based on the coverages obtained, there is reasonable assurance that, if significant service-induced degradation were occurring, evidence of it would be detected by the examinations that were performed on the subject welds. Also, the coverages obtained provide reasonable assurance of structural integrity of the subject welds.

The NRC staff has determined that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility.

Therefore, Relief Requests 3-ISI-7, Revision 1, 3-ISI-12, and 3-ISI-19 are authorized, pursuant to 10 CFR 50.55a(g)(6)(i), for the second 10-year inservice inspection (ISI) interval at Browns Ferry Unit 3, which began on November 19, 1996, and ended on November 18, 2005. The NRC staff notes that this interval has been extended consistent with the NRC staff's approval in a letter dated March 29, 2004. This letter approved TVA's request to use Subarticle IWA-2430 in its entirety and all related requirements of 1995 edition of the 1996 Addenda of the ASME Code which provided for extension of the ISI interval for up to 1 year.

The NRC staff's safety evaluation is enclosed.

Sincerely,

/RA by MChernoff for/

L. Raghavan, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-296

Enclosure: Safety Evaluation

cc w/encl: See next page

Therefore, Relief Requests 3-ISI-7, Revision 1, 3-ISI-12, and 3-ISI-19 are authorized, pursuant to 10 CFR 50.55a(g)(6)(i), for the second 10-year inservice inspection (ISI) interval at Browns Ferry Unit 3, which began on November 19, 1996, and ended on November 18, 2005. The NRC staff notes that this interval has been extended consistent with the NRC staff's approval in a letter dated March 29, 2004. This letter approved TVA's request to use Subarticle IWA-2430 in its entirety and all related requirements of 1995 edition of the 1996 Addenda of the ASME Code which provided for extension of the ISI interval for up to 1 year.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SECOND 10-YEAR INSERVICE INSPECTION INTERVAL

RELIEF REQUESTS 3-ISI-07, REVISION 1, 3-ISI-12, AND 3-ISI-19

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 3

DOCKET NUMBER 50-296

1.0 INTRODUCTION

By a letter dated March 4, 2005, as supplemented by letters dated September 26, 2005, and May 4, 2006, the Tennessee Valley Authority (TVA, the licensee) submitted Relief Requests 3-ISI-07, Revision 1, 3-ISI-12, and 3-ISI-19, requesting relief from the examination coverage requirements specified in the American Society of Mechanical Engineers (ASME) Code, Section XI, for nozzle-to-vessel welds, full-penetration piping welds and reactor vessel pressure retaining welds at Browns Ferry Nuclear Plant (BFN) Unit 3. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g)(5), the licensee proposed to exclude those welds that are inaccessible for inspection.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed and evaluated the information provided by the TVA with technical assistance from its contractor, the Pacific Northwest National Laboratory (PNNL).

2.0 REGULATORY REQUIREMENTS

The inservice inspection (ISI) of the ASME Boiler and Pressure Vessel 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). If it is determined that the Code requirements are impractical, the Commission may grant relief pursuant to 10 CFR 50.55a(g)(6)(i) and may impose such alternative requirements as it determines is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest giving due consideration to the burden upon the licensee if the requirements were imposed on the facility.

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, “Rules for

Enclosure

Inservice Inspection of Nuclear Power Plant Components," 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 ASME Code of record for the Unit 3 second 10-year interval ISI program, which began on November 19, 1996, is the 1989 Edition of the ASME Code, Section XI, no Addenda. However, this interval has been extended consistent with the NRC staff's approval in a letter dated March 29, 2004. This letter approved TVA's request to use Subarticle IWA-2430 in its entirety and all related requirements of 1995 edition of the 1996 Addenda of the ASME Code which provided for extension of the ISI interval for up to 1 year.

3.0 STAFF EVALUATION

The NRC staff, with technical assistance from its contractor, PNNL, has reviewed and evaluated the information provided by the licensee in its letter dated March 4, 2005, which proposed its Second 10-Year Interval ISI Program Plan Requests for Relief 3-ISI-07, Revision 1, 3-ISI-12, and 3-ISI-19. In response to an NRC request for additional information, the licensee provided additional information in its letter dated September 26, 2005. The NRC staff adopts the evaluations and recommendations for granting Requests for Relief 3-ISI-07, Revision 1, 3-ISI-12, and 3-ISI-19 contained in PNNL's Technical Letter Report (TLR) included as Attachment 2 to this Safety Evaluation (SE). Attachment 1 to this SE lists each relief request and the status of approval.

3.1 Relief Request 3-ISI-7, Revision 1

The ASME Code, Section XI, Table IWB-2500-1, Examination Category B-D, Items B3.90 and B3.100, "Full Penetration Welds of Nozzles in Vessels," require all Class 1 nozzle-to-shell welds and nozzle inner radius sections to be inspected during each inspection interval. The licensee proposed that, in lieu of the ASME Code required essentially 100-percent volume ultrasonic (UT) examination, it would perform a UT examination of the accessible areas, to the maximum extent practical, given the component design configuration of the reactor pressure vessel (RPV) nozzle-to-vessel welds and the Standby Liquid Control Nozzle inner radius.

For RPV Nozzle-to-Vessel Welds N1B N/V, N2A N/V, N2C N/V, N2E N/V, N3A N/V, N4A N/V, N4FN/V, N5B N/V, N9 N/V, and N7N/V, the NRC staff determined that the ASME Code-required examinations for the subject RPV nozzle-to-vessel welds are impractical to perform given the physical limitations caused by the geometries of the set-in barrel-type nozzle configurations and other access restrictions due to adjacent supports. In order for the licensee to perform the ASME Code-required examinations, the subject RPV nozzle-to-vessel welds would have to be redesigned, thus placing a significant burden on the licensee.

The RPV nozzle-to-vessel weld inspections were performed from the vessel side of the weldment and are considered to be single side access. The licensee obtained a significant level of coverage, of greater than 70 percent, for these nozzle-to-vessel welds from one side of the weld only. The licensee, did not identify any indications of significant patterns of degradation during its examinations of the RPV nozzle-to-vessel welds. Therefore, the NRC staff determined that the volumetric coverages obtained would have shown any indications of significant patterns of degradation in the subject welds and provide reasonable assurance of structural integrity of the RPV nozzle-to-vessel welds.

For the Nozzle N10 inner radius examination, the NRC staff determined that the ASME-required examinations for the Standby Liquid Control Nozzle N10-IR (inner radius) are impractical to perform because of the design geometry of the subject nozzle. The subject nozzle is designed with an integral socket to which the boron injection piping is fitted. The portion of the inner radius not inspected is associated with the inner cylindrical protrusion, or socket area, of the nozzle. This area is a region that sound beams directed from the vessel wall cannot reach. In order for the licensee to perform the ASME Code-required examinations, the Standby Liquid Control Nozzle N10-IR would have to be redesigned, thus placing a significant burden on the licensee.

The licensee noted that the Standby Liquid Control Nozzle N10-IR was inspected with the latest ultrasonic equipment, procedures and personnel qualified to Appendix VIII of the ASME Code Section XI, and a coverage of 90 percent of the ASME Code-required examination volume was obtained. The NRC staff determined that based on the type of examinations and level of coverage obtained, it is reasonable to conclude that significant degradation, should it exist, would have been detected during the examinations. Therefore, examinations performed provide reasonable assurance of structural integrity of the subject weld. For a detailed basis of relief for both the RPV nozzle-to-vessel weld and Standby Liquid Control Nozzle N10-IR examinations, see Attachment 2 of this SE.

3.2 <u>Relief 3-ISI-12</u>

The ASME Code, Examination Category R-A, Items R1.11 and R1.16, establishes the examination requirements for the full penetration piping welds. For Unit 3, welds DRHR 3-19, DRHR-3-21, TRHR-3-191, and RWCU-3-007-G004 are governed by a Risk-Informed ISI (RI-ISI) program that was approved in the NRC SE dated February 11, 2000. The RI-ISI program inspection requirements are listed in ASME Code Case N–577, *Risk-Informed Requirements for Class 1, 2 and 3 Piping, Method A*. Table 1 of ASME Code Case N–577 assigns the Examination Category R-A, Item R1.11 to piping inspection elements subject to thermal fatigue and Item R1.16 to piping inspection elements subject to intergranular stress corrosion cracking. This table requires 100 percent of the examination location volume, as described in Figures IWB-2500-7, 8, 9, 10, or 11, as applicable, for Class 1 circumferential piping welds.

The NRC staff determined that the subject piping weld configurations and base materials severely limit volumetric examinations. The limitations encountered by the licensee during the performance of the ultrasonic examinations on the subject welds caused by pipe-to-tee, valve-to-pipe and elbow-to-pipe configurations. In addition, a rule change in 10 CFR 50.55a(b)(2)(xv)(A)(2) restricts taking credit for “single-sided” examinations without qualifying a "single-sided" ASME Code, Section XI, Appendix VIII performance demonstration procedure, using flaws located on the opposite side of the weld. Because of the examination limitations, and rule change in 10 CFR, the licensee was only allowed to credit the examination coverages for the subject welds to 50 percent of the ASME Code-required volume(s). The examination coverages attained for the subject welds found no recordable indications or degradation in the examined areas.

The licensee indicated that previous ultrasonic examinations on the subject welds were conducted using the prescriptive requirements of the ASME Code, Section XI, Appendix III. Under these requirements, the examination coverage attained for each weld was 100 percent, with no recordable indications or degradation found on the examined areas.

Although only 50 percent of the RI-ISI-required coverage could be credited with the new examination requirements, the licensee applied both 45- and 60-degree shear and refracted longitudinal wave ultrasonic methods from the accessible pipe side of these welds. These methods would have provided limited volumetric coverage for the weld fusion zone and base materials on the opposite side of the welds. Given the weld configurations encountered, it is concluded that the RI-ISI-required weld and base material volumes were examined to the maximum extent practical. Current and previous examinations on the subject welds found no recordable indications or degradation in the examined areas. It is reasonable to conclude that if significant degradation were present, it would have been detected by the examinations that were performed. Therefore, based on the information contained in the licensee's submittal, and the discussion above, the NRC staff determined that the ASME Code requirements are impractical. To require the licensee to perform the ASME Code-required examinations would be a significant burden because the welds would have to be redesigned. The NRC staff furthered determined that the licensee's proposed alternative of examining the subject welds to the extent practical would have shown any indications in the subject welds and provides reasonable assurance of structural integrity in welds DRHR 3-19, DRHR-3-21, TRHR-3-191, and RWCU-3007-G004. For a detailed basis of relief for piping welds DRHR 3-19, DRHR-3-21, TRHR-3-191, and RWCU-3-007-G004, see Attachment 2 of this SE.

3.3 Relief Request 3-ISI-19

The ASME Code, Examination Category B-A, Item B1.12, requires volumetric examination, as defined by Figure IWB-2500-2, for essentially 100 percent of the length of RPV longitudinal shell welds V-1-A, V-1-B, and V-1-C. "Essentially 100-percent," as clarified by ASME Code Case N–460, is greater than 90-percent coverage of the examination volume, or surface area, as applicable. The licensee requested relief from the ASME Code 100-percent volumetric coverage requirement for the RPV longitudinal shell welds V-1-A, V-1-B, and V-1-C and proposed to perform an ultrasonic examination of accessible areas, to the maximum extent practical, given the component design and configuration of the subject welds.

The NRC staff determined that for the licensee to achieve the ASME Code-required 100-percent volumetric coverage of the subject RPV longitudinal shell welds, the vessel and many internal fixtures and appurtenances would have to be redesigned and modified. This would place a significant burden on the licensee, thus, the ASME Code-required volumetric examinations are impractical.

The licensee performed UT examinations of the subject welds using personnel, equipment and procedures qualified through the Electric Power Research Institute Performance Demonstration Initiative Program for ferritic RPV vessel welds. Twelve of the 15 longitudinal RPV shell welds received the full ASME Code-required volumetric examination. Longitudinal welds V-1-A, V-1-B, and V-1-C, which are the subject of this request, did not receive the full ASME

Code-required coverage due to obstructions from the vessel internal components. For longitudinal welds V-1-A, V-1-B, and V-1-C, the licensee obtained a significant amount of coverage, from 86 to 90 percent, of the ASME Code-required examination volume.

Therefore, the NRC staff determined it is reasonable to conclude that any significant patterns of degradation would have been detected and the volumetric coverage obtained provides reasonable assurance of structural integrity of longitudinal shell welds V-1-A, V-1-B, and V-1-C. For a detailed discussion of this relief, see Attachment 2 of this SE.

4.0 CONCLUSION

The Unit 3 Relief Requests 3-ISI-07, Revision 1, 3-ISI-12, and 3-ISI-19 have been reviewed by the NRC staff with the assistance of its contractor, PNNL. The TLR in Attachment 2 of this SE provides PNNL's evaluations. The NRC staff has reviewed the contractor's TLR and adopts the evaluations and recommendations for granting relief for the second 10-year ISI interval for Unit 3.

The NRC staff concluded that the ASME Code examination coverage requirements are impractical for the subject welds listed in Relief Requests 3-ISI-7, Revision 1, 3-ISI-12, and 3-ISI-19. Based on the coverages obtained, if significant service-induced degradation were occurring, there is reasonable assurance that evidence of it would be detected by the examinations that were performed on the subject welds, and that the coverages obtained provides reasonable assurance of structural integrity of the subject welds. Therefore, these relief requests are granted, pursuant to 10 CFR 50.55a(g)(6)(i), for the second 10-year ISI interval for Unit 3.

The NRC staff has determined that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. All other requirements of the ASME Code, Sections III and XI for which relief has not been specifically requested remain applicable, including a third party review by the Authorized Nuclear Inservice Inspector.

Attachments: 1. Table 1 - Summary of Relief Requests
2. Technical Letter Report

Principal Contributor: Thomas McLellan

Date: August 3, 2006

TECHNICAL LETTER REPORT

ON SECOND 10-YEAR INSERVICE INSPECTION INTERVAL

REQUESTS FOR RELIEF

FOR

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT

DOCKET NUMBER 50-296

1.0 INTRODUCTION

By letter dated March 4, 2005, the licensee, Tennessee Valley Authority (TVA), submitted several requests from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*. The requests are for the second 10-year inservice inspection (ISI) interval at Browns Ferry Nuclear Plant (BFN), Unit 3. In response to a U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI), the licensee submitted further information by letter dated September 26, 2005. Pacific Northwest National Laboratory (PNNL) has evaluated the requests for relief and supporting information submitted by the licensee in Section 3.0 below.

2.0 REGULATORY REQUIREMENTS

Inservice inspection (ISI) of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME *Boiler and Pressure Vessel Code* (B&PV 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). In 10 CFR 50.55a(a)(3) the regulations state that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee 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) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," 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, which was 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 ASME Code of record for Unit 3 is the second 10-year interval ISI program, which began on November 19, 1996, is the 1989 Edition of ASME Section XI, no Addenda.

3.0 TECHNICAL EVALUATION

The information provided by Tennessee Valley Authority (TVA) in support of the requests for relief from Code requirements has been evaluated and the bases for disposition are documented below.

3.1 Request for Relief 3-ISI-7, Revision 1, (TAC MC6314), Examination Category B-D, Items B3.90 and B3.100, Full Penetration Welded Nozzles in Vessels, Reactor Pressure Vessel

ASME Code Requirement: Examination Category B-D, Items B3.90 and B3.100, require 100 percent volumetric examination, as defined in Paragraph IWB-2500-7(a), of all Class 1 nozzle-to-shell welds, and nozzle inner radius sections, be performed during each inspection interval. ASME Code Case N–460, *Alternative Examination Coverage for Class 1 and Class 2 Welds*, as an alternative approved for use by the NRC in Regulatory Guide 1.147, Revision 14, *Inservice Inspection Code Case Acceptability* (RG1.147), states that a reduction in examination coverage due to part geometry or interference for any Class 1 and 2 weld is acceptable provided that the reduction is less than 10 percent, i.e., greater than 90 percent examination coverage is obtained.

Licensee's ASME Code Relief Request: In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from 100 percent volumetric examination, as required by ASME Code, for the following reactor pressure vessel (RPV) nozzle-to-shell welds and nozzle inner radius section:

Weld Number	**Nozzle Type**	**Nozzle Size (OD)**	**Volumetric Coverage**
N1B N/V	Recirculation outlet	28-inch	77%
N2A N/V	Recirculation inlet	12-inch	77%
N2C N/V	Recirculation inlet	12-inch	77%
N2E N/V	Recirculation inlet	12-inch	77%
N3A N/V	Main steam	26-inch	77%
N4A N/V	Feedwater	12-inch	77%
N4F N/V	Feedwater	12-inch	77%
N5B N/V	Core spray	10-inch	71%
N9 N/V	CRD control	4-inch	74%

Weld Number	Nozzle Type	Nozzle Size (OD)	Volumetric Coverage
N7 N/V	Vent	4-inch	70%
N10 IR (inner radius)	Standby liquid control	2-inch	90%

Licensee Basis for Relief (as stated):

The design configuration of the subject nozzle-to-vessel welds precludes ultrasonic (UT) examination of essentially 100 percent of the required examination volume. Access to the nozzle-to-vessel welds is by a series of doorways in the concrete biological shield wall. Insulation behind these doorways is designed for removal around the nozzle circumference. In order to examine the welds in accordance with the code requirements the RPV would require extensive design modifications. The physical arrangements of the nozzle-to-vessel welds precludes UT examination from the nozzle side. The limitations are inherent to the barrel-type nozzle-to-vessel weld design and are compounded by the close proximity of the biological shield wall. Scanning from the nozzle surface is ineffective due to the weld location and the asymmetrical inside surface where the nozzle and vessel converge. Coverage was increased by scanning from the outside bend radius of the weld where practical.

The small bend radius of the N10 nozzle configuration prevents 100 percent coverage from the bend area. Experience from the automated UT examination performed from the inside surface has shown that the nozzle-to-vessel weld coverage will not be greatly improved even if performed from the inside surface utilizing the current state-of-the-art techniques. The configuration of the nozzle-to-vessel welds precludes UT examination from the nozzle side due to the weld location and the asymmetrical inside surface where the nozzle and vessel converge. The extent of examination coverage from the vessel side provides reasonable assurance that no flaws oriented parallel to the weld are present. The areas receiving little or no examination coverage are located toward the outside surface of the reactor vessel in the general area of the nozzle outside bend radius. (The bend radius restricts the scanning movement and/or transducer contact.)

The reactor vessel inner-half of the thickness and inside surface are interrogated with the UT beam. Degradation located at the inside surface or inner-half of the vessel would be located. It should be noted that the nozzle inside radius section, with the exception of –10 IR, received essentially 100 percent examination coverage. The Standby Liquid Control nozzle, –10, is designed with an integral socket to which the boron injection piping is welded. This integral socket area is included in the exam boundary as indicated in ASME Section XI, Figure IWB-2500-7. The nozzle location, below the core support plate, prevents examination from the vessel interior; therefore, the exam must be performed from the vessel outside surface of the vessel head. Because of the small diameter of the nozzle (i.e., approximately 2 inches) and the thickness of the head (i.e., approximately 6 inches), the ratio of the nozzle diameter to the head thickness make it impractical to perform an examination from the nozzle-to-head radius bend surface. Also, to perform the ultrasonic examination from the head surface, the sound must travel through the full thickness of the head into a complex cladding/socket configuration. The geometric configuration inherent to the design prevent 100 percent coverage from being achieved on the inside radius section of the nozzle.

Radiographic examination as an alternate volumetric examination method was determined to be impractical due the radiological concerns. Gaining access to the inside surface of the RPV to place radiographic film would require extensive personnel protection due to high radiation and contamination levels. Also, due to the varying thickness at the outside bend radius of the weld several radiographs may be required of one area to obtain the required coverage and/or film density. The additional Code coverage gained by radiography is impractical when weighed against the radiological concerns.

Therefore, TVA concludes that performing an UT examination of essentially 100 percent of the nozzle-to-vessel full penetration welds, and the Standby Liquid Control Nozzle inner radius area in the RPV would be impractical. Further, it would also be impractical to perform other volumetric examinations (i.e., radiography) which may increase examination coverage. A maximum extent practical UT examination of the subject areas provides an acceptable level of quality and safety. TVA concludes that significant degradation, if present, would be detected during an UT examination performed to the maximum extent practical of the subject welds. As a result, reasonable assurance of operational readiness of the subject welds has been provided.

Licensee's Proposed Alternative Examination (as stated):

None. In lieu of the Code required essentially 100 percent volume UT examination, TVA proposes a UT examination of the accessible areas, to the maximum extent practical, given the component design configuration of the RPV nozzle-to-vessel welds and the Standby Liquid Control Nozzle inner radius.

Evaluation: The ASME Code of record for BFN-3 Second 10-year ISI interval is the 1989 Edition, with no Addenda, for component selection. For the ten RPV nozzle-to-shell full penetration welds, ASME Code requires volumetric examination of essentially 100 percent of the weld and adjacent base material as shown in Figure IWB-2500-7(a). For the one nozzle inner radius examination, ASME Code requires a volumetric examination of essentially 100 percent of the nozzle inner radius as depicted in Figure IWB-2500-7(a).

RPV Nozzle-to-Vessel Weld Examinations

Based on the drawings and descriptions[1] provided by the licensee, the UT examinations were performed on accessible areas of the subject welds to the maximum extent practical, given the physical limitations caused by the geometries of the set-in barrel-type nozzle configurations, and other access restrictions due to adjacent supports.

1. Drawings and physical descriptions supplied by the licensee are not included in this report.

In order to conduct an effective inservice inspection the welds must be properly prepared and the licensee reported that the welds were machined and ground flush with the vessel and into the radius bend of the nozzle on the outside of the vessel. The licensee stated that the machined surfaces require a 250 finish or better unless otherwise noted. (Note there were no units provided, but this type of measurement generally refers to 250 micro-inches RMS.) However, the examinations completed during BFN-3 Cycle 10 refueling outage (Spring 2000) were performed prior to the implementation of the NRC's "Final Rule" in 10 CFR 50.55a(g)(6(ii)(C), and did not use ASME Section XI, Appendix VIII qualification criteria. Thus, these inspections were conducted to requirements of the 1989 Edition of the ASME Code. The 1989 Edition of ASME Code requires that examinations on vessel welds be conducted with an inspection sensitivity of 20 percent Distance-Amplitude Compensation (DAC). This means that an examination reference sensitivity is established using calibration standards with side-drilled holes and surface notches. This reference sensitivity, or level, relates to a specific instrument gain, which results in a certain amplitude of response from these reference reflectors. However, as the metal sound path (time) to these reflectors increases, the corresponding amplitude is diminished due to attenuation within the material. For this reason, a DAC curve is established to amplitude compensate for a change in metal path on any given calibration reflector. Some threshold, or percent of DAC, is typically employed to establish reporting criteria for unknown flaw responses detected during examinations. The 1989 Edition, and earlier versions, of ASME XI used this type of amplitude-based method to assess whether a detected response should be reported, or ignored.

Prior to 1986, the ASME Code sensitivity requirements were for 50 percent DAC, but as a result of the Program for the Inspection of Steel Components, Phase II (PISC II), the inspection sensitivity was increased to 20 percent DAC for the 1986 and future Editions. The PISC II[2] program showed that there was a substantial improvement between the detection performance going from 50 percent DAC to 20 percent DAC, but there was no further improvement in performance going to 10 percent DAC. Additionally, the effectiveness of the 20 percent DAC procedures are dependent on the type of defect. PISC II found that volumetric defects were easy to detect and 100 percent detection was shown for defects of 5 mm in through wall size, while for smooth cracks with sharp edges this performance was not achieved until the through wall dimension reached approximately 33 mm. In the PISC II program there were also special procedures (non-amplitude based) that were employed and these performed better than any of the DAC based procedures and have many similarities with the procedures that have successfully qualified to ASME Code Section XI, Appendix VIII.

The inspections at BFN-3 were performed from only the vessel side of the weldment, and thus, are considered to be single side access. However, a significant level of coverage (greater than 70 percent) was obtained for these nozzle-to-vessel welds from one side of the weld only. In addition, studies such as PISC I, II and III, and others, have found that the inspections conducted through carbon steel are equally effective whether the ultrasonic waves have only to propagate through the base metal, or have to

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2. *Ultrasonic Inspection of Heavy Section Steel Components*, The PISC II Final Report, 1988, Edited by R. W. Nicholls and S. Crutzen, Elsevier Applied Science, New York, NY.

also propagate through the carbon steel weldment[3]. Thus, single-side inspections on the subject nozzle-to-vessel welds should not be significantly limited, other than for potential flaw tilt and skew. One of the weaknesses of the amplitude based procedures using sensitivities such as 20 percent DAC is that the response of flaws can decrease substantially because of flaw tilt or skew, and the effect becomes larger the farther the flaw is located away from the transducer. However, if the flaw intersects the far surface (as expected for service-induced cracking), the corner trap effect significantly aides in the detection of the flaw and compensates for signal losses from skew and tilt.

Based on the ultrasonic examination methods applied, and examination coverages obtained, for the RPV nozzle-to-vessel welds listed above, and considering the impracticality of performing full ASME volumetric examinations, it is reasonable to conclude that significant degradation, should it exist, would have been detected during these examinations. Therefore, it is recommended that relief be granted for the subject RPV nozzle-to-vessel welds.

Nozzle N10 Inner Radius Examination

For the inspection of the inner radius, BFN-3 used ASME Code Case N–552, *Alternative Methods - Qualification for Nozzle Inside Radius Section from the Outside Surface*. This ASME Code Case has been conditionally accepted for use by the NRC in Revision 14 of RG1.147, and requires modeling to be conducted to establish the maximum mis-orientation angle that a given inspection is capable of accommodating. Although the work documenting this activity was not provided, it is expected that the modeling was conducted and followed during the inspection.

Standby Liquid Control nozzle inner radius N10-IR is designed with an integral socket to which the boron injection piping is fit (see figure below). The inspection must be conducted from the vessel side and, because of the design geometry of the nozzle, it is impractical to inspect the full inner radius for this nozzle. The portion of the inner radius not inspected is associated with the inner cylindrical protrusion, or socket area of the nozzle. This area is a region that sound beams directed from the vessel wall cannot reach, therefore, it is impractical to meet the 100 percent ASME Code volumetric coverage requirement. The licensee stated that N10-IR was inspected with the latest ultrasonic equipment, procedures and personnel qualified to Appendix VIII of the ASME Code Section XI, and estimated the coverage to be 90 percent of the ASME Code-required volume.

Based on the impracticality of examining the full ASME Code volume, given the design of the subject inner radius section, and because the licensee has obtained 90 percent of the ASME Code-required coverage with performance demonstrated ultrasonic methods, it is concluded that significant degradation, should it exist, would have been detected by the examination performed. Therefore, it is recommended that relief be granted for the N10-IR inner radius section.

Conclusion:

Considering the impracticality of examining the full ASME Code-required volumes on the subject welds and inner radius section, and based on the type of examinations and levels of coverages obtained, it is reasonable to conclude that significant degradation, should it exist, would have been detected during the examinations of these RPV nozzle-to-shell welds and inner radius section. Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), it is recommended that relief be granted.

3.2 Request for Relief 3-ISI-12, (TAC MC6386), Examination Category R-A, Items R1.11 and R1.16, Full Penetration Piping Welds Governed by the Risk-Informed Program

ASME Code Requirement: The examination requirements for the subject piping welds at BFN-3 are governed by a Risk-Informed Inservice Inspection (RI-ISI) program that was approved by the NRC in an SE dated February 11, 2000. The RI-ISI program was developed in accordance with WCAP-14572, Rev. 1-NP-A, *Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report* (WCAP). As part of the NRC-approved program, the licensee has implemented inspection requirements listed in ASME Code Case N–577, *Risk-Informed Requirements for Class 1, 2 and 3 Piping, Method A*, with more detailed provisions contained in the WCAP. Table 1 of ASME Code Case N–577 assigns the Examination Category R-A, Item R1.11 to piping inspection elements subject to thermal fatigue and Item R1.16 to piping inspection elements subject to inter-granular stress corrosion cracking (IGSCC). This table requires 100 percent of the examination location volume, as described in Figures IWB-2500-7, 8, 9, 10, or 11, as applicable, for Class 1 circumferential piping welds. ASME Code Case N–460, *Alternative Examination Coverage for Class 1 and Class 2 Welds*, as an alternative approved for use by the NRC in Revision 14 of RG1.147, states that a reduction in examination coverage due to part geometry or interference for any Class 1 and 2 weld is acceptable provided that the reduction is less than 10 percent, i.e., greater than 90 percent examination coverage is obtained.

Licensee's ASME Code Relief Request: In accordance with 10 CFR 50.55a(a)(3)(i), the licensee has proposed an alternative to the volumetric examination coverage requirements contained in Table 1 of ASME Code Case N–577 for the following Class 1 piping welds:

Weld	**System**	**Configuration**	**Coverage Obtained**
DRHR-3-19	Residual Heat Removal	Pipe-to-tee	50%
DRHR-3-21	Residual Heat Removal	Elbow-to-valve	50%
TRHR-3-191	Residual Heat Removal	Elbow-to-valve	50%
RWCU-3-007-G004	Reactor Water Clean Up	Pipe-to-valve	50%

Licensee Basis for Relief (as stated):

The welds were examined with the latest ultrasonic techniques, procedures, equipment, and personnel qualified to the requirements of the Performance Demonstration Initiative (PDI) Program, in accordance with the requirements of the 1995 Edition, 1996 Addenda of ASME Section XI, Division 1, Appendix VIII as mandated by 10 CFR 50.55a(g)(4).

It is not possible to perform the volumetric ultrasonic examination from both sides of the weld due to the configuration of these components. An ultrasonic examination was performed on the piping welds of the accessible areas, to the maximum extent practical, due to the configuration. Credit for the one-sided only ultrasonic examination provided 50 percent coverage because of a new requirement mandated in 10 CFR 50.55a(a)(b)(2)(XV)(2), which states in part, "Where examination from both sides is not possible on austenitic welds, full coverage credit from a single side may be claimed only after completing a successful single sided Appendix VIII demonstration using flaw on the opposite side of the weld . . . ." Additionally, there is no Appendix VIII Program for cast austenitic piping welds; therefore, only 50 percent coverage can be claimed. Under the original ASME Section XI Code requirements UT coverage attained was 100 percent.

Weld DRHR-3-19 limitations were due the configuration of the component, Tee-to-Pipe weld.

Weld DRHR-3-21 limitations were due the configuration of the component, Elbow-to-Pipe weld.

Weld TRHR-3-191 limitations were due the configuration of the component, Cast Austenitic Valve-to-Elbow weld.

Weld RWCU-3-007-G004 limitations were due the configuration of the component, Pipe-to-Cast Austenitic Valve weld.

The performance of the ultrasonic examination of the subject areas, to the maximum extent practical, provides an acceptable level of quality and safety because the information and data obtained from the volume examined provides sufficient information to judge the overall integrity of the piping welds.

Licensee's Proposed Alternative Examination (as stated):

In lieu of the ASME Code-required essentially 100 percent (i.e., greater than 90 percent) volumetric examination, TVA proposes an ultrasonic examination of accessible areas to the maximum extent practical, given the component design configuration of the aforementioned piping welds.

Evaluation: The examination requirements for the subject piping welds at BFN-3 are governed by an RI-ISI program that was approved by the NRC in an SE dated December 16, 1998. This program assigns Examination Category R-A, Item R1.11 to piping inspection elements subject to thermal fatigue, Item R1.16 to piping elements subject to IGSCC, and requires inspection of 100 percent of the examination location volume, as described in Figures IWB-2500-7, 8, 9, 10, or 11, as applicable, for Class 1 circumferential piping welds. However, the subject piping weld configurations and base materials severely limit volumetric examinations. In order to meet the RI-ISI program volumetric coverage requirements, these components would have to be redesigned and modified. Therefore, 100 percent volumetric examination is not considered to be feasible for the subject piping welds.

TVA has determined that certain BFN-3 welds had ultrasonic examination coverage limitations of less than 100 percent of the ASME Code-required weld and adjacent material volume(s). The limitations encountered during the performance of the ultrasonic examinations on Welds DRHR-3-19, DRHR-3-21, TRHR-3-191 and RWCU-3-007-G004 were caused by pipe-to-tee, valve-to-pipe and elbow-to-pipe configurations (see Table above). In addition, a rule change in 10 CFR 50.55a(b)(2)(xv)(A)(2) restricts taking credit for "single-sided" examinations without qualifying a "single-sided" ASME Code, Section XI, Appendix VIII performance demonstration procedure, using flaws located on the opposite side of the weld. Because of the examination limitations, and rule change in CFR, the licensee was only allowed to credit the examination coverages for the subject welds to 50 percent of the ASME Code-required volume(s). The examination coverages attained for the subject welds found no recordable indications or degradation in the examined areas.

Previous ISI interval ultrasonic examinations on the subject welds were conducted using the prescriptive requirements of the ASME Code, Section XI, Appendix III. Under these requirements the examination coverage attained for each weld was 100 percent, with no recordable indications or degradation found on the examined areas.

Though previous and current UT examination scan paths and angles are similar, the current coverage requirements are based on using a procedure qualified to ASME Code, Section XI, Appendix VIII, Supplements 2 and 3. At the time of the examinations, no qualified procedure existed for single-side austenitic welds. The regulation at 10 CFR 50.55a(b)(2)(xv) requires that if access is available, the weld shall be scanned in each of the four directions (parallel and perpendicular to the weld on each side of the weld centerline). Coverage credit may be taken for single-side examinations on austenitic piping if a procedure is qualified with flaws on the inaccessible side of the weld. This procedure must demonstrate single-side access examinations equivalency to "two-sided" examinations. Instead of a full single-side qualification, the industry's Electric Power Research Institute (EPRI) Performance Demonstration Initiative (PDI) offers a best-effort approach, intended to demonstrate that the best available technology and ultrasonic methods are applied.

Although only 50 percent of the ASME Code-required coverage could be credited, the licensee applied both 45 and 60 degree shear and refracted longitudinal wave ultrasonic methods from the accessible pipe side of these welds. These methods would have provided limited volumetric coverage for the weld fusion zone and base materials on the opposite side of the welds. Given the weld configurations encountered, it is concluded that the ASME Code-required weld and base material volumes were examined to the maximum extent practical. Current and previous examinations on the subject welds found no recordable indications or degradation in the examined areas. It is reasonable to conclude that if significant degradation were present, it would have been detected by the examinations that were performed.

Based on the information contained in the licensee's submittal and the discussion above, it has been determined that the ASME Code-requirements are impractical. To require the licensee to perform the ASME Code-required examinations would be a significant burden because the welds would be required to be redesigned thus the ASME Code-requirements are impractical. The NRC staff further determined that the licensee's proposed alternative of examining the subject welds to the extent practical would have shown any indications in the subject welds and provides a reasonable assurance of structural integrity of welds DRH 3-19, DRHR-3-21, TRHR-3-191, and RWCU-3-007-G004. Therefore, it is recommended that relief be granted pursuant to 10 CFR 50.55a(a)(g)(6)(i), for the second 10-year ISI interval at BFN-3.

3.3 Request for Relief 3-ISI-19 (TAC MC6387), Examination Category B-A, Item B1.12, Pressure Retaining Welds in Reactor Vessel

ASME Code Requirement: Examination Category B-A, Item B1.12, requires volumetric examination, as defined by Figure IWB-2500-2, for essentially 100 percent of the length of longitudinal shell welds in the reactor pressure vessel (RPV). "Essentially 100 percent", 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 Revision 14 of RG1.14.

Licensee's ASME Code Relief Request: In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code 100 percent volumetric coverage requirement for the RPV longitudinal shell welds shown below:

Weld Number	Weld Type	Volume Completed
V-1-A	Longitudinal shell	90%
V-1-B	Longitudinal shell	86%
V-1-C	Longitudinal shell	89%

Licensee's Basis for Requesting Relief: (as stated)

Areas of the V-1-A, V-1-B, and V-1-C welds are inaccessible for UT examination due to the design configuration of the RPV and vessel internals. The examinations were performed with automated ultrasonic equipment from the vessel inside surface utilizing the Advanced Inservice Reactor Inspection System 21 device, (AIRIS 21) and Enhanced Data Acquisition System-II equipment (EDAS™-II). The V-1-A, V-1-B, and V-1-C RPV longitudinal shell weld scans were obstructed by a jet pump restrainer bracket and jet pump diffuser.

Licensee's Proposed Alternative Examination (as stated):

None. In lieu of the ASME Code-required essentially 100 percent (i.e., greater than 90 percent) volume ultrasonic examination, TVA proposes an ultrasonic examination of accessible areas, to the maximum extent practical, given the component design, and configuration of the subject welds.

Evaluation: The ASME Code requires 100 percent volumetric examination of the subject RPV longitudinal shell welds, however, access limitations restrict volumetric coverages on the subject welds. For the licensee to achieve 100 percent volumetric coverage of these RPV longitudinal shell welds, the vessel and many internal fixtures and appurtenances, would have to be redesigned and modified. This would place a significant burden on the licensee, thus the ASME Code-required 100 percent volumetric examinations are impractical.

Ultrasonic examination of these welds was conducted using personnel, equipment and procedures qualified through the Electric Power Research Institute (EPRI) Performance Demonstration Initiative (PDI) Program for ferritic pressure vessel welds. The longitudinal weld examinations were performed from the inside of the vessel with a remote scanning device. The device was designed to be positioned over the longitudinal seams and rotated 90-degrees to enable ultrasonic scans in both parallel and perpendicular directions, respective to the weld axis. However, the scans of longitudinal welds V-1-A, V-1-B and V-1-C were obstructed by the jet pump restrainer bracket and jet pump diffuser.

As shown on the sketches and technical descriptions provided by the licensee,[3] a significant amount (from 86 to 90 percent) of the required examination volume coverage was obtained for the subject longitudinal shell welds. In order for the licensee to examine the total ASME Code-required examination volume, the jet pump diffusers would have to be removed. This would require extensive modification to the RPV and the diffuser assemblies. There is no access to these longitudinal welds from the vessel outside diameter due to the biological shield wall and RPV insulation.

BFN-3 has fifteen longitudinal welds in the RPV shell courses. Twelve of these welds received the full ASME Code (essentially 100 percent) coverage. Only the three welds that are the subject of this request did not receive the ful ASME Code-required coverage due to obstructions from the vessel internal components. However, as stated above, a significant level of coverage was obtained for these three welds. In addition, all the examinations were performed using EPRI PDI qualified equipment, personnel and procedures. Based on the impracticality of examining 100 percent of the subject welds, and the examination coverages obtained on these and other RPV longitudinal welds, it is reasonable to conclude that any significant patterns of degradation would have been detected. Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), it is recommended that relief be granted.

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4. Drawings, descriptions and reports of examinations provided as part of the licensee's submittal are not included in this report.

4.0 CONCLUSIONS

PNNL has reviewed the licensee's submittal and concludes that the ASME Code examination coverage requirements are impractical for the subject welds listed in Request for Relief 3-ISI-7, Revision 1, Request for Relief 3-ISI-12, and Request for Relief 3-ISI-19. Based on the coverages obtained, if significant service-induced degradation were occurring, there is reasonable assurance that evidence of it would be detected by the examinations that were performed. Therefore, for these requests, it is recommended that relief be granted, pursuant to 10 CFR 50.55a(g)(6)(i), for the second inspection interval at Browns Ferry Nuclear Plant, Unit 3.

BROWNS FERRY NUCLEAR PLANT, UNIT 3
Second 10-Year ISI Interval

TABLE 1
SUMMARY OF RELIEF REQUESTS

Relief Request Number	PNNL TLR RR Sec.	System or Component	Exam. Category	Item No.	Volume or Area to be Examined	Required Method	Licensee Proposed Alternative	Relief Request Disposition
3-ISI-7, Revision 1	3.1	Reactor Pressure Vessel Nozzles	B-D	B3.90 B3.100	100 percent of all full penetration RPV nozzle-to-shell welds, and inside radius section	Volumetric	Use percent of ASME Code volume obtained	Granted 10 CFR 50.55a(g)(6)(i)
3-ISI-12	3.2	Piping Welds under RI-ISI Program	R-A	R1.11 R1.16	100 percent of all full penetration piping welds subject to IGSCC and thermal fatigue	Volumetric	Use percent of ASME Code volume obtained	Granted 10 CFR 50.55a(g)(6)(i)
3-ISI-19	3.3	Reactor Pressure Vessel Shell Welds	B-A	B1.12	100 percent of length of longitudinal shell welds in RPV	Volumetric	Use percent of ASME Code volume obtained	Granted 10 CFR 50.55a(g)(6)(i)