



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

January 31, 2011

Mr. Michael J. Annacone, Vice President
Brunswick Steam Electric Plant
Carolina Power & Light Company
Post Office Box 10429
Southport, North Carolina 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – REQUEST FOR
ALTERNATIVES TO THE REACTOR PRESSURE VESSEL NOZZLE-TO-VESSEL
WELD AND INNER RADIUS EXAMINATIONS (TAC NOS. ME3854 AND ME3855)

Dear Mr. Annacone:

By letter dated April 29, 2010, as supplemented by letter dated August 17, 2010, Carolina Power & Light Company (the licensee) submitted a request to the Nuclear Regulatory Commission (NRC) for the use of alternatives to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV Code), Section XI requirements at Brunswick Steam Electric Plant (BSEP), Units 1 and 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. The licensee proposed to use ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," as an alternative to ASME Code, Section XI regarding inservice inspection (ISI) of reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee's proposed alternative provides an acceptable level of quality and safety, and that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i) and is in compliance with the ASME Codes' requirements. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC authorizes the licensee's proposed alternative for inspection of the RPV nozzle-to-vessel shell welds and nozzle inner radii sections listed in Attachment 1 of Enclosure 1 of the licensee's April 29, 2010, submittal at BSEP Units 1 and 2 through the end of the fourth 10-year ISI interval, which ends on May 10, 2018 for both units.

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

M. Annacone

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The bases for the NRC staff's conclusion are contained in the enclosed safety evaluation. If you have any questions regarding this issue, please contact Farideh Saba at (301) 415-1447 or farideh.saba@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Doug A. Broaddus". The signature is fluid and cursive, with the first name "Doug" being more prominent.

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

Docket Nos. 50-325 and 50-324

Enclosure: Safety Evaluation

cc w/encl: Distribution via Listserv



UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ALTERNATIVES TO THE REACTOR PRESSURE VESSEL

NOZZLE-TO-VESSEL WELD AND INNER RADIUS INSERVICE INSPECTION

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

DOCKET NUMBERS 50-325 AND 50-324

1.0 INTRODUCTION

By a letter dated April 29, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101310390), supplemented by a letter dated August 17, 2010 (ADAMS Accession No. ML102360176), Carolina Power & Light Company (CP&L), the licensee for Brunswick Steam Electric Plant (BSEP), Units 1 and 2, submitted to the Nuclear Regulatory Commission (Commission, NRC), Alternative Request Number ISI-05, requesting for relief from the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," pertaining to examinations of reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii at BSEP, Units 1 and 2. The licensee proposed to use ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," as an alternative.

The technical basis for ASME Code Case N-702 is documented in an Electric Power Research Institute report by the Boiling Water Reactor Vessel and Internals Project-108 (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 Radius," which was approved by the NRC in a safety evaluation (SE) dated December 19, 2007, (ADAMS Accession No. ML073600374). The December 19, 2007, SE for the BWRVIP-108 report specifies plant-specific requirements that must be met for the plants proposing to use this alternative. The licensee's submittal intended to demonstrate that the relevant BSEP, Units 1 and 2, RPV nozzle-to-vessel welds and nozzle inner radii meet the plant-specific requirements so that the relief request can be authorized.

2.0 REGULATORY EVALUATION

Inservice inspection (ISI) of the ASME Code Class 1, 2, and 3 components is performed in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) of 10 CFR states that alternatives to the requirements of

Enclosure

paragraph (g) may be used, when authorized by the staff, 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.

Section 50.55a(g)(4) of 10 CFR states further that ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except for design and access provisions and preservice examination requirements, set forth in the ASME Code, Section XI, to the extent practical within the limitations of the design, geometry, and materials of construction of the components. The regulations require that ISI examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable ISI code of record for the third 10-year ISI interval of the BSEP, Units 1 and 2 is the 2001 Edition of ASME Code, Section XI, 2003 Addenda.

For 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 ISI interval. The NRC staff has approved BWRVIP-108, the underlying technical basis document for ASME Code Case N-702. The December 19, 2007, SE regarding BWRVIP-108 specified the following plant-specific requirements to be satisfied by the licensees using ASME Code Case N-702:

Licensees 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/cooldown rate is limited to less than 115 °F/hr;

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
 $C_{RPV} = 19332$,

- (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
 $C_{NOZZLE} = 1637$

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
 $C_{RPV} = 16171$, 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
 $C_{NOZZLE} = 1977$

This plant-specific information was required by to ensure that the probabilistic fracture mechanics (PFM) analysis documented in the BWRVIP-108 report applies to the RPV of the licensee's plant.

The code of record for the fourth 10-year ISI interval at BSEP, Units 1 and 2 is the ASME Code, Section XI, 2001 Edition with 2003 Addenda. The fourth 10-year interval began on May 11, 2008, and will end on May 10, 2018, for BSEP, Units 1 and 2.

3.0 TECHNICAL EVALUATION OF RELIEF REQUEST

3.1 The Licensee's Request for Alternative ISI-05

Components for Which Relief is Requested

Code Class: 1

Components:

Recirculation Inlet Nozzles N2A, N2B, N2C, N2D, N2E, N2F, N2G, N2J, and N2K

Main Steam Nozzles N3A, N3B, N3C, and N3D

Core Spray Nozzles N5A and N5B

Reactor Pressure Vessel Head Spray Nozzles N6A and N6B

Jet Pump Instrumentation Nozzles N8A and N8B

Instrumentation Nozzles N11A, N11B, N12A, N12B, N16A and N16B

Details of affected vessel nozzle assemblies are provided in Attachment 1 of Enclosure 1 of the licensee's April 29, 2010 submittal.

Examination Category: B-D

Item Number: B3.90 and B3.100

Applicable ASME Code Edition and Addenda

The licensee requested relief from the following requirements of ASME Code, Section XI, 2001 Edition, 2003 Addenda:

Table IWB-2500-1 "Examination Category B-D, Full Penetration Welded Nozzle in Vessels - Inspection Program B"

Class 1 nozzle-to-vessel weld and nozzle inner radii examination requirements are given in B3.90 "Nozzle-to-Vessel Welds" and B3.100 "Nozzle Inside Radius Section." All nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles, but excluded manways and handholes, must be examined during each ISI interval. The method of examination is volumetric. All of the nozzle assemblies identified in Attachment 1 of Enclosure 1 of the April 29, 2010, submittal are full penetration welds.

Licensee's Proposed Alternative Examination

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee requested relief from performing the required examination on 100 percent of the identified nozzle assemblies (Enclosure 1 of the April, 29, 2010, submittal). As an alternative for all welds and nozzle inner radii, the licensee proposed to volumetrically examine a minimum of 25 percent of the nozzle-to-vessel welds and inner radius sections, including at least one nozzle from each system and nominal pipe size, with the exception of recirculation outlet nozzles, in accordance with ASME Code Case N-702. The licensee proposed to inspect at least one nozzle/inner radius section from each of the identified nozzle assemblies in Attachment 1 of Enclosure 1 of the April 29, 2010, submittal.

Licensee's Bases for Alternative

The licensee stated that the BWRVIP-108 report is used as the basis for ASME Code Case N-702. The BWRVIP-108 evaluation found that failure probabilities at the nozzle blend radius region and nozzle-to-vessel shell weld due to a low temperature overpressure event are very low (i.e., less than 1×10^{-6} for 40 years) with or without ISI. The BWRVIP-108 report concluded that inspection of 25 percent of each nozzle type is technically justified. Section 5.0 "Plant-Specific Applicability" of the NRC staff's SE for the BWRVIP-108 report indicated that each licensee that 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 BWRVIP-108 report as the technical basis for the use of ASME Code Case N-702 as an alternative. The licensee, in Enclosure 2 of its letter dated April 29, 2010, addressed the applicability of the following general and nozzle-specific criteria for applicability of BWRVIP-108 for the BSEP, Units 1 and 2.

- (1) The maximum RPV heatup/cooldown rate is limited to less than 115°F/hr.

Technical Specification 3.4.9, "Reactor Coolant System Pressure and Temperature Limits," for BSEP, Units 1 and 2, mandates that the heat up and cooldown rates shall be less than, or equal, to 100°F/hr, which is less than

115°F/hr. Hence it meets Criterion 1 in Section 5.0 of the staff's SE for the BWRVIP-108 report dated December 19, 2007..

(2) Criteria 2 and 3 for the recirculation inlet nozzles:

(a) $(pr/t)/C_{RPV} < 1.15,$

The calculation for N2 nozzles results in 1.03, which is less than 1.15; hence it meets Criterion 2 in Section 5.0 of the NRC staff's SE for the BWRVIP-108 report dated December 19, 2007.

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

The calculation N2 nozzles results in 1.04, which is less than 1.15, hence it meets Criterion 3 in Section 5.0 of the staff's SE for the BWRVIP-108 report dated December 19, 2007.

(3) Criteria 4 and 5 for the recirculation outlet nozzles:

(a) $(pr/t)/C_{RPV} < 1.15,$

The calculation for the N1 nozzles results in 1.23, which is greater than 1.15, and does not meet Criterion 4 in Section 5.0 of the NRC staff's SE for the BWRVIP-108 report.

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

The calculation for the N1 nozzles results in 0.94, which is less than 1.15, and meets Criterion 5 in Section 5.0 of the NRC staff's SE for the BWRVIP-108 report.

Based upon the above evaluation, the licensee concluded that all RPV nozzle-to-vessel shell welds and nozzle inner radii sections described in Enclosure 1 of the April 29, 2010, submittal meet the criteria specified in Section 5.0 of the NRC staff's SE for the BWRVIP-108 report. Therefore, ASME Code Case N-702 is applicable to these items. The licensee also concluded that ASME Code Case N-702 is not applicable to the recirculation outlet nozzles, since these nozzles do not meet the criteria specified in Section 5.0 of the staff's SE for the BWRVIP-108 report.

In addition, the licensee in its April 29, 2010, letter noted that ASME Code Case N-702 stipulates that a VT-1 (visual) examination method may be used in lieu of the volumetric examination method for the inner radius sections. The licensee stated that CP&L has adopted ASME Code Case N-648-1, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles," with the provisions stipulated in Regulatory Guide (RG) 1.147, "Inservice Inspection Code Case acceptability, ASME Section XI, Division 1," in the BSEP ISI Program for the fourth inspection interval.

In conclusion the licensee stated that, pursuant to 10 CFR 50.55a(a)(3)(i), use of ASME Code Case N-702 provides an acceptable level of quality and safety for all RPV nozzle-to-vessel shell welds and nozzle inner radii welds described in Enclosure 1 of the April 29, 2010, submittal.

3.2 NRC Staff's Evaluation

The NRC staff's SE for the BWRVIP-108 report specified five plant-specific criteria that licensees must evaluate to demonstrate that the BWRVIP-108 report results are applicable to their plants for use of ASME Code Case N-702. The five criteria are related to the PFM analyses for the recirculation inlet and outlet nozzles. The NRC staff's SE for BWRVIP-108 states that the nozzle material fracture toughness-related RT_{NDT} values used in the PFM analyses were based on data from the entire fleet of BWR RPVs. Therefore, the BWRVIP-108 PFM analyses are bounding with respect to fracture resistance. It was also stated that, except for the RPV heatup/cooldown rate, the plant-specific criteria are applicable to 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.

In the April 29, 2010, submittal, the licensee provided its evaluation of the licensee's proposed alternative against five criteria established in the NRC staff's SE for BWRVIP-108. The results of these evaluations bound all nozzles included in Enclosure 1 of April 29, 2010, submittal. The licensee's evaluation indicated that the fourth criterion related to recirculation outlet nozzles was not satisfied. The licensee's evaluation indicated that, with exception for the fourth criterion related to the recirculation outlet nozzles, all other criteria are satisfied. Based on the results of the evaluation, the licensee determined that the reduced inspection requirements, in accordance with ASME Code Case N-702, do not apply to the BSEP, Units 1 and 2 RPV recirculation outlet nozzles. The NRC staff reviewed the licensee's evaluation by using the guidelines of the NRC SE dated December 19, 2007, for BWRVIP-108 report, and verified the licensee's calculation results. The NRC staff also found the licensee's decision to exclude the BSEP, Units 1 and 2, RPV recirculation outlet nozzles from the scope of this request is appropriate.

To ensure that there is no active aging degradation in the identified nozzle welds, the NRC staff requested that the licensee confirm the previous ultrasonic test results of the aforementioned nozzle welds did not show any service induced defects. By letter dated August 17, 2008, the licensee confirmed that the previous ultrasonic results indicated no service induced defects in these welds. Absence of any defects in the subject welds indicates no active aging degradation in these welds; therefore, the NRC staff's concern is resolved satisfactorily.

Carbon/low alloy steel welds are not subject to stress corrosion cracking (SCC), whereas nickel-base alloy welds (specifically welds fabricated with shielded metal arc welding process using Alloy 182 weld material, designated as UNS W86182, F-No. 43) are subject to SCC in a BWR environment. For Alloy 182 welds, the reduction in inspection requirements as permitted per ASME Code Case N-702 is not allowed and Alloy 182 welds must be examined per Table IWB-2500-1 of the ASME Code, Section XI criteria. Therefore, the NRC does not grant relief from the inspection criteria specified in Table IWB-2500-1 of the ASME Code, Section XI for Alloy 182 welds. In this context, the NRC staff requested that the licensee provide information regarding the type of weld metal that was used for the nozzle welds described in this relief request. By a letter dated August 17, 2010, the licensee stated that the nozzle welds identified

in its relief request, are fabricated with low alloy steel weld metal. Since welds included in the licensee's request are low alloy steel welds, with no active aging degradation, the NRC staff finds ASME Code Case N-702 applicable to these welds.

Further, as stated in Section 3.1 of this SE, the licensee has adopted ASME Code Case N-648-1 with the provisions stipulated in RG 1.147 in the BSEP ISI Program for the fourth ISI interval. The condition placed on the use of ASME Code Case N-648-1 is that "in place of UT [ultrasonic] examination, licensees may perform a visual examination with enhanced magnification that has a resolution sensitivity to detect a 1-mil width wire or crack" The NRC staff finds the licensee's request consistent with the NRC position regarding VT-1 examination in RG 1.147, since the VT-1 examination in the BSEP ISI program for the fourth ISI interval complies with the above-stated condition. Therefore, the NRC staff concludes that the licensee's proposed alternative examination is acceptable as it provides reasonable assurance of verifying structural integrity of the nozzle's inner radii.

The NRC staff reviewed the licensee's justification for using the guidelines addressed in the BWRVIP-108 report as technical bases for adopting ASME Code Case N-702 for the RPV nozzle-to-vessel shell welds and nozzle inner radii sections described in Enclosure 1 of the April 29, 2010, submittal, and finds it acceptable based on the following:

- (1) The licensee successfully demonstrated that the RPV nozzle-to-vessel shell welds and nozzle inner radii sections of the subject nozzles described in Enclosure 1 of the April 29, 2010, submittal meet the requirements of the BWRVIP-108 report and the plant-specific criteria specified in the staff's December 19, 2007, SE for the BWRVIP-108 report;
- (2) Previous ultrasonic results of the subject welds detected no defects, which indicated that there was no active aging degradation in these welds;
- (3) The nozzles welds addressed in the relief request are fabricated with low alloy weld metals which are not subject to SCC. Therefore, reduction in inspection requirements per ASME Code Case N-702 for these welds is applicable;
- (4) PFM analyses of BWRVIP-108 are bounding with respect to fracture resistance of nozzles addressed in Enclosure 1 of the licensee's request dated April 29, 2020; and
- (5) The licensee's proposed alternative examination for the nozzle's inner radii is consistent with the NRC position regarding VT-1 examination in RG 1.147.

Based on the above, the NRC staff determined that the licensee's proposed alternative for the RPV nozzle-to-vessel shell welds and nozzle inner radii sections of the nozzles described in Enclosure 1 of the licensee's submittal dated April 29, 2010, as supplemented by letter dated August 17, 2010, provides an acceptable level of quality and safety.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's submittal dated April 29, 2010, and the additional information provided in its August 17, 2010, supplement, requesting relief from the 100 percent

inspection of RPV nozzle-to-vessel shell welds and nozzle inner radii specified by the ASME Code, Section XI, 2001 Edition, 2003 Addenda, and proposed alternative of using the ASME Code Case N-702 for the fourth 10-year ISI interval. The NRC staff finds that those BSEP, Units 1 and 2, RPV nozzle to vessel shell welds and nozzle inner radii sections listed in Attachment 1 of Enclosure 1 of the licensee's April 29, 2010, submittal meet the criteria specified in the NRC staff's December 19, 2007, SE for the BWRVIP-108 report, which provides the NRC staff's technical bases for the use of ASME Code Case N-702. The NRC staff also finds the licensee's adoption of ASME Code Case N-648-1 consistent with the NRC position stipulated in RG 1.147 provides reasonable assurance of structural integrity of the nozzles' inner radii.

As set forth above, the NRC staff determines that that the licensee's proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i) and is in compliance with the ASME Codes' requirements. Therefore, the NRC authorizes the licensee's proposed alternative for inspection of the RPV nozzle-to-vessel shell welds and nozzle inner radii sections listed in Attachment 1 of Enclosure 1 of the licensee's April 29, 2010, submittal at BSEP, Units 1 and 2 through the end of the fourth 10-year ISI interval, which ends on May 10, 2018 for both units.

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

Principal Contributor: Ganesh Cheruvenki

Date: January 31, 2011

M. Annacone

- 2 -

The bases for the NRC staff's conclusion are contained in the enclosed safety evaluation. If you have any questions regarding this issue, please contact Farideh Saba at (301) 415-1447 or farideh.saba@nrc.gov.

Sincerely,

/RA/

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

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