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

June 21, 2011

Mr. Preston Gillespie
Site Vice President
Oconee Nuclear Station
Duke Energy Carolinas, LLC
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, RELIEF REQUEST 10-ON-001 FOR REACTOR VESSEL CORE FLOOD NOZZLE WELD EXAMINATIONS (TAC NOS. ME4333, ME4334, ME4335, ME4336, ME4337, AND ME4338)

Dear Mr. Gillespie:

By letter dated June 9, 2010, as supplemented March 2, 2011, Duke Energy Carolinas, LLC (Duke, the licensee), submitted Relief Request (RR) 10-ON-001 for the fourth 10-year interval of Oconee Nuclear Station, Units 1, 2, and 3 (Oconee 1/2/3) related to the Inservice Inspection (ISI) Program pertaining to alternatives to the volumetric examination requirements of the American Society of Mechanical Engineers, *Boiler and Pressure Vessel Code* (ASME Code), Section XI, for the specified ASME Code Class 2, Examination Category C-B, Item No. C2.32 decay heat cooler nozzle-to-shell welds at Oconee 1/2/3

Based on the information provided by the licensee, the Nuclear Regulatory Commission (NRC) staff has determined that the licensee's proposed alternatives will provide an acceptable level of quality and safety for the residual heat removal decay heat coolers at Oconee 1/2/3. Therefore, pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.55a(a)(3)(ii), the NRC authorizes the ISI Program alternatives proposed in RR 10-ON-001 for the fourth 10-year ISI intervals of Oconee 1/2/3, which are scheduled to end on July 14, 2014, for Oconee 1/2/3. Enclosed is the NRC's Safety Evaluation.

If you have any questions concerning this action, please contact John Stang of my staff at 301-415-1345.

Sincerely,

Gloria Kulesa, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, and 50-287

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR APPROVAL OF RELIEF 10-ON-001

REGARDING ALTERNATIVES TO VOLUMETRIC EXAMINATION REQUIREMENTS

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3

DUKE ENERGY CAROLINAS, LLC

DOCKET NOS. 50 269, 50-270, AND 50-287

1.0 INTRODUCTION

By letter dated June 9, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101660473), as supplemented March 2, 2011 (ADAMS Accession No. ML11144A078), Duke Energy Carolinas, LLC (Duke, the licensee), submitted Relief Request (RR) 10-ON-001 for the fourth 10-year Interval Inservice Inspection (ISI) Program at Oconee Nuclear Station, Units 1, 2, and 3 (Oconee 1/2/3). RR 10-ON-001 proposed an alternative to the volumetric examination requirements of the American Society of Mechanical Engineers, *Boiler and Pressure Vessel Code* (ASME Code), Section XI, for the specified ASME Code Class 2, Examination Category C-B, Item No. C2.32 for decay heat cooler nozzle-to-shell welds at Oconee 1/2/3. The U. S. Nuclear Regulatory Commission (NRC) staff reviewed the licensee's request pursuant to the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, paragraph 50.55a(a)(3)(i).

NRC staff has reviewed the licensee's proposed alternative pursuant to10 CFR 50.55a(a)(3)(ii) on the basis that compliance to the Code requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.0 REGULATORY REQUIREMENTS

ISI of 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 10 CFR 50.55a(g), except where specific relief has been granted by the NRC pursuant to 10 CFR 50.55a(g)(6)(i). Paragraph 50.55a(a)(3) states 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

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 pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for 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 regulation requires 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 Code of record for the fourth 10-year interval ISI Program at Oconee 1/2/3 is the 1998 Edition of the ASME Code, Section XI through the 2000 Addenda. The fourth 10-year interval ISI Program at Oconee Unit 1 began on January 1, 2004, and is scheduled to end on July 14, 2014. The fourth 10-year interval ISI program at Oconee Unit 2 began on September 9, 2004, and is scheduled to end on July 14, 2014. The fourth 10-year interval ISI program at Oconee Unit 3 began on January 2, 2005, and is scheduled to end on July 14, 2014.

The information provided by the licensee in support of the relief request has been evaluated by the NRC staff and the bases for disposition are documented below.

3.0 TECHNICAL EVALUATION

The licensee's fourth 10-year interval ISI Program request (RR 10-ON-001) addresses the ASME Code Class 2, Examination Category C-B, Item No. C2.32 components at Oconee 1/2/3 listed below.

Low Pressure Injection (LPI) Residual Heat Removal (RHR) Heat Exchangers (Decay Heat Coolers) Tube Side Inlet and Outlet Nozzle-to-Shell Welds for:

- Oconee 1 Decay Heat Cooler 1A, Nozzles M and N
- Oconee 1 Decay Heat Cooler 1B, Nozzles M and N
- Oconee 2 Decay Heat Cooler 2A, Nozzles M and N
- Oconee 2 Decay Heat Cooler 2B, Nozzles M and N
- Oconee 3 Decay Heat Cooler 3A, Nozzles M and N
- Oconee 3 Decay Heat Cooler 3B, Nozzles M and N
  (12 decay heat cooler nozzle-to-shell welds in total).

Applicable ASME Code, Section XI Requirements

The 1998 Edition through the 2000 Addenda of the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.32 requires a volumetric examination for all RHR heat exchanger nozzle-to-shell welds for nozzles with a reinforcing plate in vessels greater than 0.5 inch nominal thickness, when the inside of the heat exchanger vessel is accessible. The required examination volume is specified in Figure IWC-2500-4(c) of the ASME Code, Section XI.

Licensee's Proposed Alternative and Basis for Use

ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item C2.32 requires a volumetric examination of the RHR heat exchanger nozzle-to-shell welds when the inside of the vessel is accessible.

The licensee plans to remove the channel cover from each of the RHR heat exchangers (decay heat coolers) to permit eddy current examination of the heat exchanger tubes during the fourth 10-year ISI interval at Oconee 1/2/3. These activities will enable access to the interior of the heat exchangers. Accordingly, a volumetric examination of accessible nozzle-to-shell welds would be required in order to satisfy the requirement of Table IWC-2500-1, Examination Category C-B, Item No. C2.32.

The licensee stated that performing volumetric examinations of the subject decay heat cooler nozzle-to-shell welds is unnecessary because the proposed alternative provides an acceptable level of quality and safety. The proposed alternative will also eliminate all radiation dose associated with performing these volumetric examinations.

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee proposed the following alternative in lieu of the volumetric examinations required by Table IWC-2500-1, Examination Category C-B, Item No. C2.32 for the tube side inlet and outlet nozzle-to-shell welds for the RHR heat exchangers (decay heat coolers):

(1) Surface examinations shall be performed in accordance with Table IWC-2500-1, Examination Category C-B, Item No. C2.31.

(2) A VT-2 visual examination shall be performed in accordance with Table IWC-2500-1, Examination Category C-B, Item No. C2.33 during each inspection period while the heat exchanger vessel is undergoing the system leakage test.

(3) A VT-2 visual examination shall be performed on the RHR heat exchangers in accordance with Table IWC-2500-1, Examination Category C-H, Item No. C7.10 during each inspection period while the heat exchanger vessel is undergoing the system leakage test.

The Westinghouse Owner's group (WOG) performed a study as part of the ASME approval process for ASME Code Case N-706, "Alternative Examination Requirements of Table IWB-2500-1 and IWC-2500-1 for PWR Stainless Steel Residual and Regenerative Heat Exchangers, Section XI, Division 1." This study, as documented in the WOG report "Technical Basis for Revision of Inspection Requirements for Regenerative and Residual Heat Exchangers," August 2004, provided technical justification for eliminating the volumetric examination of RHR heat exchanger components. The decay heat coolers at Oconee 1/2/3 are typical of the heat exchangers described in the WOG report, with respect to fabrication, design, inspection requirements and geometric restrictions.

The WOG report also addressed flaw tolerance and risk assessment for these components. Fracture evaluations were performed for the components using finite element models. It was concluded that the heat exchangers have a large flaw tolerance and that significant leakage

would be expected long before any failure occurred. Fatigue crack growth was determined to be extremely slow even in the most highly stressed region. These heat exchangers do not have a severe duty cycle, and there are no known degradation mechanisms applicable to the tube side nozzle-to-shell welds. The licensee stated, volumetric examinations of the subject decay heat cooler nozzle-to-shell welds are not required to ensure their integrity.

A risk evaluation was performed using the accepted methodology applied for risk-informed ISI programs. This evaluation resulted in the following conclusions:

- Safety equipment required to respond to a potential event is unaffected.
- Potential for loss of pressure boundary integrity is negligible.
- No safety analysis margins are changed.
- Leakage before full break is expected, and there are no core damage consequences associated with leakage.

Based on the conclusions of the WOG report, the elimination of the volumetric examinations required by Table IWC-2500-1, Examination Category C-B, Item No. C2.32 is expected to result in no significant increase in risk. The WOG report indicated that there have been no through-wall leaks in these components or components of similar design reported in the industry. The WOG report indicated that one plant (San Onofre, Unit 3) had experienced a small leak from the letdown line exiting the Class 1 regenerative heat exchanger; however, this was caused by excessive vibration on the piping line and is not an indication of a defect in the heat exchanger.

The licensee also stated that Oconee 1/2/3 Selected Licensee Commitment (SLC) 16.6.4 currently limits LPI system leakage to 2 gallons per hour (gph), and LPI system leakage is periodically monitored. Any system leakage through the tube side inlet and outlet nozzle-to-shell welds would likely be detected by operations personnel during plant rounds performed each week, which include the LPI decay heat cooler (RHR heat exchanger) rooms. Any identified leakage from these welds would be noted and entered into the site corrective action program.

NRC Staff's Evaluation

The NRC staff reviewed the information provided by the licensee concerning RR 10-ON-001 for the fourth 10-year interval ISI Program at Oconee 1/2/3. RR 10-ON-001 proposes an alternative to the ASME Code, Section XI-required volumetric examinations for the Class 2 tube side inlet and outlet nozzle-to-shell welds for RHR Decay Heat Coolers 1A, 1B, 2A, 2B, 3A, and 3B. Each of the subject welds is a full penetration weld which joins the nozzle weld during system leakage tests when the inside of the heat exchanger vessel is inaccessible for volumetric examination. A separate fillet weld joins the reinforcing plate to the heat exchanger shell. This welded configuration is illustrated in Figure IWC-2500-4(c) of the ASME Code, Section XI.

According to the licensee, the channel covers will be removed from each of the subject RHR heat exchangers in order to permit eddy current examinations of the heat exchanger tubes. The removal of these channel covers will permit access to the interior of heat exchangers, which would enable the performance of the volumetric examinations of the subject nozzle-to-shell welds, as required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32. The NRC staff noted that volumetric examinations of these welds are required only when the inside of the heat exchangers are accessible.

The licensee stated that the nozzle-to-shell weld volumetric examinations required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 are not necessary because the proposed alternative will provide an acceptable level of quality and safety. The licensee also stated that the proposed alternative will eliminate all personnel radiation dose associated with performing these volumetric examinations. The NRC staff finds with the licensee's statement that the elimination of the ASME Code, Section XI-required volumetric examinations for the subject RHR heat exchanger nozzle-to-shell welds would result in a reduction in personnel radiation dose, because the elimination of these examinations reduces the time spent in a high radiation environment.

The NRC staff reviewed the licensee's proposed alternative to the volumetric examinations required by Examination Category C-B, Item No. C2.32 to determine whether it will provide an acceptable level of quality and safety. The licensee's proposed alternative involves (1) performing surface examinations on the external surface of the subject welded joints, where the full penetration weld joins the nozzle to the reinforcing plate, including the separate fillet weld joining the heat exchanger shell to the reinforcing plate, as required by Examination Category C-B, Item No. C2.31; (2) performing VT-2 visual examinations of the joints by examining the "telltail hole" in the reinforcing plate for evidence of leakage while the heat exchanger vessel is undergoing the system leakage test, as required by the Examination Category C-B, Item No. C2.33; and (3) performing VT-2 visual examinations of all pressure retaining components of the heat exchangers during system leakage tests, as required by Examination Category C-H, Item No. C7.10.

The NRC staff noted that the licensee's proposed alternative, as stated in RR 10-ON-001 involves the fulfillment of the other ASME Code, Section XI requirements pertaining to the examination of this welded joint, and therefore does not constitute a specific alternative per se to the volumetric examination requirement specified under Examination Category C-B, Item No. C2.32. However, the NRC staff found that the licensee's description and referencing of a previous fracture and fatigue analysis performed by WOG for these heat exchangers may be used as part of an alternative basis for the elimination of volumetric examinations for the subject decay heat cooler nozzle-to-shell welds at Oconee 1/2/3. The analysis, as documented in WOG project MUHP 5093, Working Group Inservice Inspection Optimization Action 97-01 (Boiler Code Item BC03-338), "Technical Basis for Revision of Inspection Requirements for Regenerative and Residual Heat Exchangers," August 2004, was performed as part of the ASME Boiler and Pressure Vessel Standards Committee approval process for ASME Code Case N-706, "Alternative Examination Requirements of Table IWB-2500-1 and IWC-2500-1 for PWR Stainless Steel Residual and Regenerative Heat Exchangers, Section XI, Division 1." The WOG report provided technical justification for the elimination of the volumetric and surface examinations required by the ASME Code, Section XI, Table IWB-2500-1 for Class 1 regenerative heat exchangers and Table IWC-2500-1 for Class 2 RHR heat exchangers. The WOG report noted that these heat exchangers were designed and installed before the ISI requirements of the ASME Code, Section XI were required to be implemented by the industry. As a result, the design of these heat exchangers does not accommodate the successful performance of meaningful ultrasonic examinations. The small diameter of the vessels and nozzles of these heat exchangers make it difficult to perform ultrasonic examinations with meaningful results. The examinations are very time consuming and result in high dose rates to the personnel performing the examinations because the heat exchangers are located in high radiation fields. The subject decay heat cooler nozzle-to-shell welds at Oconee 1/2/3 are included in the scope of components addressed in the

WOG report. The decay heat coolers at Oconee 1/2/3 are typical of the RHR heat exchangers addressed in the WOG report with respect to materials, fabrication, design, inservice examination requirements, and geometric restrictions.

As stated by the licensee, the WOG report addressed flaw tolerance and risk assessment for these components. Flaw tolerance assessments were based on fracture and fatigue analyses for the RHR heat exchanger components using finite element methods. The WOG report concluded that the RHR heat exchangers have a large flaw tolerance and that significant leakage would be expected long before any failure occurred. Fatigue crack growth was determined to be extremely slow even in the most highly stressed region. The WOG report also determined that there are no active degradation mechanisms applicable to the tube side nozzle-to-shell welds for the RHR heat exchangers. The nozzle-to-shell welds are low alloy steel and therefore, not susceptible to stress corrosion cracking. Therefore, the WOG report concluded that volumetric examinations of the subject decay heat cooler nozzle-to-shell welds are not required in order to ensure their integrity.

The NRC staff finds with the licensee's determination that the findings of the WOG report, in conjunction with the performance of surface and visual examinations on the subject welds, as required by Examination Category C-B, Item Nos. C2.31 and C2.33, would provide an acceptable alternative basis for eliminating the nozzle-to-shell weld volumetric examinations required by Examination Category C-B, Item No. C2.32, provided that no prior findings of leakage or age-related degradation have been discovered in the subject components.

The reinforcing plate covers the heat exchanger shell in the vicinity of each nozzle and incorporates a "telltail hole" that allows for the performance of a VT-2 visual examination of a small area of the shell near the full penetration.

In the March 2, 2011, supplement, the licensee stated that VT-2 visual examinations performed on the RHR heat exchangers/decay heat coolers at Oconee 1/2/3 during the first, second, third, and fourth 10-year ISI intervals have not detected any evidence of leakage for the heat exchangers, including the nozzle-to-shell welds for which relief was requested. The licensee further stated that surface examinations performed on the nozzle M and N reinforcing plate-to-nozzle welds and reinforcing plate-to-shell welds for the decay heat coolers at Oconee 1/2/3 during the first, second, third, and fourth 10-year ISI intervals have not detected any unacceptable indications. The licensee stated that the decay heat cooler nozzle-to-shell welds for which relief has been requested have not received any prior inservice volumetric examinations. However, according to the licensee, prior volumetric examinations of the decay heat coolers' adjacent shell-to-head flange and shell-to-tubesheet flange welds at Oconee 1/2/3 during the first, second, third, and fourth 10-year ISI intervals have not detected any unacceptable indications. The licensee stated that these other volumetric examinations of the decay heat cooler pressure boundary components provide reasonable assurance that the service conditions within the decay heat coolers have not resulted in any age-related degradation in the nozzle-to-shell welds for which relief was requested.

The NRC staff reviewed the licensee's March 2, 2011, supplement and determined that is acceptable because (1) no evidence of leakage has been detected as a result of VT-2 visual examinations performed during system leakage tests for the decay heat coolers at Oconee 1/2/3; (2) previous surface examinations of nozzle M and N reinforcing plate-to-nozzle welds and

reinforcing plate-to-shell welds for the subject decay heat coolers (as required by Examination Category C-B, Item No. C2.31) have not detected any unacceptable indications; and (3) while the subject decay heat cooler nozzle-to-shell welds have not received any previous volumetric examinations, the absence of any evidence of service-induced degradation for any other decay heat cooler pressure-retaining components provides additional assurance that these specific welds have not and will not experience significant service-induced degradation during plant service.

Based on the above evaluation, the NRC staff determined that the licensee's proposed alternative to the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 requirements for volumetric examination of the subject decay heat cooler nozzle-to-shell welds at Oconee 1/2/3 will provide an acceptable level of quality and safety. The licensee's implementation of the Examination Category C-B, Item No. C2.31 surface examination and Item No. C2.33 VT-2 visual examination requirements, in conjunction with the analyses documented in the WOG report, provide assurance of continued structural integrity for the decay heat cooler nozzle-to-shell welds at Oconee 1/2/3.

4.0 CONCLUSION

Based on the above evaluation of Request 10-ON-001, the NRC staff concludes that the licensee's proposed alternative to the volumetric examination requirements of the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 will provide an acceptable level of quality and safety for the RHR decay heat coolers at Oconee 1/2/3. Therefore, RR 10-ON-001 is authorized pursuant to 10 CFR 50.55a(a)(3)(i) for the fourth 10-year interval ISI Program at Oconee 1/2/3. 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: C. Sydnor

Date: June 21, 2011

If you have any questions concerning this action, please contact John Stang of my staff at 301-415-1345.

Sincerely,

/RA/

Gloria Kulesa, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, and 50-287

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