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

April 30, 2016

Mr. Scott Batson
Site Vice President
Oconee Nuclear Station
Duke Energy Carolinas, LLC
7800 Rochester Highway
Seneca, SC 29672-0752

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3 - RELIEF REQUEST NO. 14-ON-002 ALTERNATIVE REQUIREMENTS FOR CLASS 2 RESIDUAL HEAT REMOVAL HEAT EXCHANGER WELDS (CAC NOS. MF6296, MF6297, AND MF6298)

Dear Mr. Batson:

By letter dated May 4, 2015, Duke Energy Carolinas, LLC (the licensee) requested U.S. Nuclear Regulatory Commission (NRC) authorization to use an alternative to the requirements of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for the Oconee Nuclear Station, Units 1, 2, and 3 (ONS) as identified in Relief Request No. 14-ON-002. Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the licensee requested authorization to implement the alternative provisions of ASME Code Case N-706-1 in lieu of the ASME Code Section XI volumetric examination requirements for the specified ASME Code Class 2 Residual Heat Removal heat exchanger tube side inlet and outlet nozzle-to-shell welds for the Oconee Nuclear Station, Units 1, 2 and 3.

The NRC staff has concluded that the use of the proposed alternative described in Relief Request No. 14-ON-002 provides an acceptable level of quality and safety. As stated in the enclosed Safety Evaluation, the staff has determined that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of the proposed alternative described in Relief Request No. 14-ON-002 at ONS, for the remainder of the fifth 10-year Inservice Inspection interval, which commenced on July 15, 2014, and will end on July 15, 2024.

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

If you have any questions, please contact the ONS Senior Project Manager, Mr. James R. Hall, at randy.hall@nrc.gov or 301-415-4032.

Sincerely,

Michael T. Markley, 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

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING RELIEF REQUEST 14-ON-002

REGARDING RESIDUAL HEAT REMOVAL SYSTEM HEAT EXCHANGER WELDS

DUKE ENERGY CAROLINAS, LLC

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3

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

1.0 INTRODUCTION

By letter dated May 4, 2015 (Agencywide Documents Access and Management System Accession No. ML15132A278), Duke Energy Carolinas, LLC (Duke, the licensee) submitted Relief Request No. 14-ON-002 (Request 14-ON-002) for the fifth 10-year interval of the inservice inspection (ISI) program at Oconee Nuclear Station, Units 1, 2, and 3 (Oconee 1, 2, and 3). In Request 14-ON-002, the licensee proposed an alternative to the examination requirements of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for specific ASME Code Class 2 Residual Heat Removal (RHR) heat exchanger components at Oconee 1, 2, and 3.

2.0 REGULATORY EVALUATION

ISI of ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code, including the applicable edition and addenda, as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g), except where specific relief has been granted by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). Pursuant to 10 CFR 50.55a(z), alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if (1) the proposed alternatives would provide an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year ISI interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code

incorporated by reference in 10 CFR 50.55a(a)(1)(ii), 12 months prior to the start of the 120-month interval, subject to the conditions listed in 10 CFR 50.55a(b)(2).

The regulations in 10 CFR 50.55a(g)(4)(iv) state that inservice examination of components and system pressure tests may meet the requirements set forth in subsequent editions and addenda that are incorporated by reference in paragraph 10 CFR 50.55a(a), subject to the limitations and modifications listed in 10 CFR 50.55a(b) and subject to Commission approval. Portions of editions or addenda may be used provided that all related requirements of the respective editions or addenda are met.

Oconee 1, 2, and 3 are currently in the fifth 10-year ISI interval. The fifth 10-year ISI interval at Oconee 1, 2, and 3 began on July 15, 2014, and is scheduled to end on July 15, 2024. The applicable ASME Code of record for the fifth 10-year ISI interval at Oconee 1, 2, and 3 is the 2007 Edition of the ASME Code, Section XI, with the 2008 Addenda.

3.0 TECHNICAL EVALUATION

Components for Which an Alternative is Requested

Request 14-ON-002 proposes an alternative to the requirements of the ASME Code, Section XI for the Class 2 Low Pressure Injection (LPI) RHR Heat Exchangers (also referred to as "Decay Heat Coolers"), tube side inlet and outlet nozzle-to-shell welds at Oconee 1, 2, and 3. The subject components and relevant ASME Code examination requirements are identified in Table IWC-2500-1 of the ASME Code, Section XI, Examination Category C-B, Item No. C2.32. The specific RHR heat exchanger nozzles for Oconee 1, 2 and 3 are identified below.

- 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).

ASME Code, Section XI Examination Requirements for Which an Alternative is Requested

The 2007 Edition with the 2008 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 Reason for Requesting an Alternative

The licensee stated that it plans to remove the channel cover from each of the subject RHR heat exchangers to permit eddy current examination of the heat exchanger tubes during the

current (fifth) 10-year ISI interval at Oconee 1, 2, and 3. The licensee indicated that, because these activities will enable access to the interior of the heat exchangers, a volumetric examination of the accessible nozzle-to-shell welds would be required in order to satisfy the requirements of the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.32.

The licensee noted that eddy current examinations on the RHR heat exchangers are scheduled during plant operation (just prior to refueling outages) in order to minimize radiological dose, which is considerably higher during plant shutdown. The licensee estimated that the radiological dose for performing the required volumetric examinations for all three Oconee units is 0.60 to 0.90 rem during plant operation, compared to 4.2 to 6.6 rem during refueling outages. The licensee indicated that performing the Code-required volumetric examination for these nozzle-to-shell welds is unnecessary because the proposed alternative provides an acceptable level of safety and quality. The licensee stated that the proposed alternative will also eliminate all radiological dose associated with performing these volumetric examinations.

Licensee's Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(z)(1), the licensee proposed to implement an alternative to the volumetric examinations required by the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.32 for the RHR heat exchanger tube side inlet and outlet nozzle-to-shell welds at Oconee 1, 2, and 3, when the inside of the heat exchanger vessel is accessible. The provisions of the licensee's proposed alternative are:

(1) A VT-2 visual examination shall be performed in accordance with ASME Code Case N--06-1, "Alternative Examination Requirements of Table IWB-2500-1 and Table IWC-2500-1 for PWR [Pressurized-Water Reactor] Stainless Steel Residual and Regenerative Heat Exchangers, Section XI, Division 1," for the RHR heat exchanger reinforcing plate welds to the nozzle and vessel.

(2) A VT-2 visual examination shall be performed in accordance with the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.33 for the subject RHR heat exchanger nozzle-to-shell welds, as required when the inside of the heat exchanger vessel is inaccessible.

(3) A VT-2 visual examination shall be performed on the RHR heat exchangers in accordance with the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-H, Item No. C7.10 during each inspection period.

The licensee cited a 2004 Westinghouse Owners Group (WOG) study that was performed for the ASME Code Committee approval process for ASME Code Case N-706. The licensee stated that the WOG report provided technical justification for eliminating the volumetric examinations for the Class 1 regenerative heat exchangers and Class 2 RHR heat exchangers. The licensee stated that the RHR heat exchanger components at Oconee are typical of the RHR heat exchangers described in the WOG report in fabrication, design, inspection requirements, and geometric restrictions.

The licensee stated that the WOG report addresses flaw tolerance and risk assessment for these components. The licensee indicated that fracture evaluations were performed for the

components using finite element models and fracture calculations, and it was concluded that these heat exchangers have a large flaw tolerance and that significant leakage would be expected long before any failure occurred. The licensee stated that fatigue crack growth was determined to be extremely slow even in the most highly stressed region. The licensee noted that these heat exchangers do not have a severe duty cycle, and there are no known degradation mechanisms applicable to the tube side inlet and outlet nozzle-to-shell welds for these RHR heat exchangers. Thus, the licensee determined that volumetric examinations are not required to ensure the integrity of the RHR heat exchanger tube side inlet and outlet nozzle-to-shell welds at Oconee 1, 2, and 3.

The licensee stated that a risk evaluation was performed using the accepted methodology applied for risk informed ISI piping inspection programs. The risk evaluation arrived at 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.

Thus, the licensee determined that the elimination of the volumetric examinations required by Table IWC-2500-1, Examination Category C-B, Item C2.32 is expected to result in no significant increase in risk. The licensee also indicated that there have been no through-wall leaks for these components or components of similar design. The licensee stated that it performed a review of industry operating experience and did not identify any reports of through-wall leaks in this RHR heat exchanger design subsequent to the publication date of the WOG report.

In addition to the provisions of the WOG report, the licensee also identified that the Oconee Selected Licensee Commitment 16.6.4 currently limits LPI RHR system leakage to 2 gallons per hour. The licensee indicated that LPI RHR system leakage is monitored on a weekly basis by Operations personnel, and any system leakage through the subject heat exchanger welds would likely be detected during these plant rounds. The licensee stated that any identified leakage would be noted and entered into the site corrective action program.

The licensee noted that the volumetric examination requirements for the RHR heat exchanger nozzle-to-shell welds are required only if the interior of the heat exchanger is accessible. For this reason, the licensee ascertained that the level of quality and safety afforded by the proposed alternative is equivalent to that provided by other types of RHR heat exchangers where the interior of the heat exchangers are not considered to be accessible.

The licensee stated that previous ISI of the RHR heat exchangers have not detected any signs of leakage or age-related degradation in the subject RHR heat exchanger welds at Oconee 1, 2, and 3. The licensee concluded that, for the reasons discussed above, the proposed alternative will provide an acceptable level of quality and safety.

NRC Staff Evaluation

The NRC staff reviewed the information provided by the licensee concerning Request 14-ON-002 for the fifth 10-year ISI interval at Oconee 1, 2, and 3 to determine whether the licensee's proposed alternative will provide for adequate assurance of structural integrity for the subject RHR heat exchanger welds and, therefore, provide an acceptable level of quality and safety. Request 14-ON-002 specifically proposes an alternative to the volumetric examinations required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 for the tube side inlet and outlet nozzle-to-shell welds in the Class 2 RHR heat exchangers at Oconee 1, 2, and 3 (identified as Decay Heat Coolers 1A, 1B, 2A, 2B, 3A, and 3B for Oconee 1, 2, and 3, respectively). Each of the subject welds is a full penetration weld that joins the RHR heat exchanger shell and the reinforcing plate to the heat exchanger nozzle. The reinforcing plate covers the heat exchanger shell in the vicinity of each nozzle and incorporates a "telltale hole" that allows for the performance of a VT-2 visual examination of a small area of the shell near the full penetration 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, as stated in ASME Code Item No. C2.32.

The NRC staff reviewed the licensee's description of a 2004 fracture and fatigue analysis performed by the WOG, which determined that the volumetric examinations may be eliminated for the subject RHR heat exchanger nozzle-to-shell welds. This analysis is 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, and it 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." ASME Code Case N-706, including Revision 1 of this Code Case (N-706-1), allows for the performance of VT-2 visual examinations for the subject Class 2 RHR heat exchanger tube side inlet and outlet nozzle-to-shell welds at Oconee 1, 2, and 3 in lieu of the volumetric examinations required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32, consistent with the licensee's proposed alternative.

The NRC staff noted that ASME Code Case N-706-1 is included in Table 1, "Acceptable Section XI Code Cases," of NRC Regulatory Guide (RG) 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 17, August 2014. Therefore, this Code Case is acceptable to the NRC staff for implementation in licensees' ISI programs without NRC authorization for a plant-specific Code alternative under 10 CFR 50.55a(z), provided that all provisions of the Code Case are satisfied. Note (2) of Table 1 of Code Case N-706-1 specifies that all heat exchanger welds that are subject to the alternative VT-2 examination

provisions identified in Table 1 of the Code Case (other than the reinforcing plate welds) shall have received at least one volumetric examination. The licensee stated in its submittal for Request 14-ON-002 that the subject RHR heat exchanger nozzle-to-shell welds have not previously received the requisite volumetric examination, as specified in Note (2) of Table 1 of Code Case N-706-1. Therefore, since this provision of the Code Case is not satisfied for the subject RHR heat exchanger nozzle-to-shell welds at Oconee 1, 2, and 3, the NRC staff determined that implementation of the examination provisions of the Code Case for the subject components requires NRC authorization of a plant-specific alternative to the subject ASME Code, Section XI examination requirements, pursuant to 10 CFR 50.55a(z). Notwithstanding this provision, the NRC staff determined that the underlying WOG analysis – because it was originally used to support the ASME Code Committee's approval of this Code Case – can also be used to support the licensee's plant-specific technical basis for its proposed alternative to implement the proposed VT-2 visual examinations in lieu of the volumetric examinations required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32.

The WOG report determined that the type of RHR heat exchanger design for Oconee 1, 2, and 3 predates the ISI requirements of the ASME Code, Section XI. As a result, it was determined that the design of these heat exchangers does not accommodate the successful performance of meaningful ultrasonic examinations because the small diameter of the vessels and nozzles for these heat exchangers makes it difficult to perform volumetric examinations with meaningful results. The NRC staff confirmed the licensee's statement that these volumetric 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 NRC staff also confirmed that the subject RHR heat exchangers at Oconee 1, 2, and 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.

The NRC staff noted that 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 NRC staff confirmed that 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 subject 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 NRC staff was able to confirm the WOG conclusion that volumetric examinations of the subject RHR heat exchanger nozzle-to-shell welds are not required in order to ensure their integrity.

Based on its review of the findings of the WOG report underlying ASME Code Case N-706 and the fact that the volumetric examinations required by ASME Code Item No. C2.32 are required only when the inside of the heat exchangers are accessible, the NRC staff determined that the WOG analysis, as summarized above, may be used as a technical basis for the performance of the licensee's proposed alternative VT-2 visual examinations on the subject RHR heat exchanger nozzle-to-shell welds, provided that there have been no findings of leakage or age-related degradation in the subject heat exchanger components. In its submittal, the licensee specifically identified that previous inservice examinations of the RHR heat exchangers have not detected any signs of leakage or age-related degradation in any of these heat

exchanger welds. The NRC staff, therefore, determined that the previous inservice examinations of the RHR heat exchangers provide adequate assurance that the service conditions within the RHR heat exchangers have not resulted in any age-related degradation in the subject nozzle-to-shell welds.

Based on the above, the NRC staff determined that the licensee's proposed alternative to implement the VT-2 visual examinations in lieu of the volumetric examinations required by the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 will provide adequate assurance of continued structural integrity for the RHR heat exchanger tube side inlet and outlet nozzle-to-shell welds for the fifth 10-year ISI interval at Oconee 1, 2, and 3. Therefore, the NRC staff concludes that the licensee's proposed alternative to the ASME Code, Section XI, Examination Category C-B, Item No. C2.32 requirements for these components will provide an acceptable level of quality and safety.

4.0 CONCLUSION

Based on the above evaluation of Request 14-ON-002, 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 subject RHR heat exchanger nozzle-to-shell welds at Oconee 1, 2, and 3. Therefore, Request 14-ON-002 is authorized pursuant to 10 CFR 50.55a(z)(1) for the fifth 10-year ISI interval at Oconee 1, 2, and 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: Christopher Sydnor

Date: April 30, 2016

If you have any questions, please contact the ONS Senior Project Manager, Mr. James R. Hall, at randy.hall@nrc.gov or 301-415-4032.

Sincerely,

/RA/

Michael T. Markley, 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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