February 26, 2002

Mr. William R. McCollum, Jr.
Vice President, Oconee Site
Duke Energy Corporation
P.O. Box 1439
Seneca, South Carolina 29679

SUBJECT: OCONEE NUCLEAR STATION, UNIT 3 RE: RELIEF REQUESTS RR 01-014 AND RR 01-015 (TAC NO. MB3224)

By letter dated October 18, 2001, as supplemented by letters dated November 16 and 20, 2001, you submitted Relief Requests RR 01-14 and RR 01-15. These letters requested relief from certain requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, 1992 Edition for the reactor vessel head control rod drive mechanism penetration nozzle leak repair for Oconee Nuclear Station, Unit 3. Specifically, you proposed to perform the weld repair using alternative processes and alternatives to ASME non-destructive examination and flaw evaluation requirements.

The staff has completed its review as documented in the enclosed Safety Evaluation. For RR 01-14, the staff determined that complying with the code would result in hardship or difficulty without a compensating increase in the level of quality and safety. Therefore, RR 01-14 is authorized pursuant to 10 CFR 50.55a(a)(3)(ii). For RR 01-15, the staff determined that the proposed alternative provides an acceptable level of quality and safety. Therefore, RR 01-15 is authorized pursuant to 10 CFR 50.55a(a)(3)(i). Both reliefs are authorized for the Third 10-year interval. On December 6, 2001, the staff granted verbal approval of both of these relief requests.

Sincerely,

/RA/

Richard J. Laufer, Acting Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-287

Enclosure: As stated

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION FOR OCONEE NUCLEAR STATION, UNIT 3

RELIEF REQUESTS RR 01-014 AND RR 01-015

DOCKET NO. 50-287

1.0 INTRODUCTION

The inservice inspection (ISI) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Class 1, Class 2, and Class 3 components is to be performed in accordance with Section XI of the ASME Code and 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 Commission pursuant to 10 CFR 50.55a(g)(6)(i). 10 CFR 50.55a(a)(3) states in part 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) will 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 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) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The inservice inspection code of record for the third 10-year ISI interval at Oconee Nuclear Station, Unit 3 is the 1989 Edition with no Addenda of Section XI of the ASME Code.

By letter dated October 18, 2001, as supplemented by letters dated November 16 and 20, 2001, the Duke Energy Corporation (Duke), the licensee, submitted Relief Request RR 01-14 which requested relief from certain welding repair requirements. Specifically, the licensee requested relief from the ASME Code, Section XI 1989 Edition, subparagraph IWA-4622, which requires elevated temperature preheat and post-weld soaks, that will result in added radiation dose to repair personnel. As an alternative, Duke proposed to perform the repair with a remotely operated weld tool, utilizing the machine gas tungsten-arc welding (GTAW) process and the ambient temperature temper bead method with 50 °F minimum preheat temperature and no post-weld heat treatment (PWHT). The repairs will be conducted in accordance with the 1992 Edition of ASME (as applicable), the 1989 Edition of Section III (as applicable), and alternative requirements discussed later herein.

Oconee Unit 3 is currently in its third 10-year ISI interval. Repair welding and inspections will be performed according to the 1989 Edition of Section III and Section XI of the Code. Their

Construction Code is the 1968 Edition with Winter 1968 Addenda of the Code, and their ISI Code of record is the 1989 Edition of Section XI of the Code. Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee requested relief from the requirements of the following Section III/Section XI Code requirements.

2.0 Reactor Pressure Vessel Closure Head Control Rod Drive Mechanism Nozzle Penetrations Repairs, Relief Request RR 01-014

The Components affected by this request for relief are the 69 control rod drive mechanism (CRDM) penetrations on the reactor pressure vessel (RPV) head. In its letters, the licensee provided the Code requirements and the licensee's basis for relief. Following is our evaluation of RR 01-014.

2.1 Evaluation

The 1989 Edition of ASME Section III, Paragraph NB-4622.11, "Temper Bead Weld Repair to Dissimilar Metal Welds or Buttering," states that whenever PWHT is impractical or impossible, limited weld repairs to dissimilar metal welds of P-No. 1 and P-No. 3 material or weld filler metal A-No. 8 (Section IX, QW-442) or F-No. 43 (Section IX, QW-432) may be made without PWHT or after the final PWHT, provided the requirements of the subparagraphs NB-4622.11(a) through (g) are met.

The licensee referenced NB-2410 regarding welding material used in the construction and repair of components or materials. NB-2410 contains the statement, "or to the requirements for other welding material as permitted in Section IX." It is the staff's opinion that endorsing Section XI of the code, in turn, endorses the latest edition of Section IX. The Section IX Code Case 2142-1 introduced and classified alloy 52 filler material. Therefore, NRC approval is not required for the use of alloy 52 weld filler material.

The requirements of paragraphs NB-4451, 4452, 4453, and 4622 of the 1989 Edition of ASME Section III are also applicable to the contemplated repairs. As an alternative to the PWHT time and temperature requirements of NB-4622, the requirements of "Similar and Dissimilar Metal Welding Using Ambient Using Ambient Temperature Machine GTAW Temper Bead Technique" will be used. Specifically, alternatives are being proposed for the following subparagraphs of ASME Section III, NB-4622:

NB-4622.1 to NB-4622.6 was discussed in detail in the submittal and do not apply since they deal with PWHT which is not going to be used for these repairs; therefore, these requirements do not apply.

NB-4622.7 establishes exemptions from mandatory PWHT requirements. Sub-subparagraphs 4622.7(a) through 4622.7(f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Sub-subparagraph NB-4622.7(g) discusses exemptions to weld repairs to dissimilar metal welds if the requirements of subparagraph NB4622.11 are met. This sub-subparagraph does not apply because the ambient temperature temper bead repair is being proposed as an alternative to the requirements of subparagraph NB4622.11.

NB-4622.8 establishes exemptions from PWHT for nozzle-to-component welds and branch connection-to-run piping welds. Sub-subparagraph 4622.8(a) establishes criteria for exemption of PWHT for partial penetration welds. This is not applicable to the proposed repairs because the criteria involve buttering layers at least 1/4 inch thick which will not exist for the welds in question. Sub-subparagraph NB-4622.8(b) also does not apply because it discusses full penetration welds and the welds in question are specially designed pressure boundary, structural welds.

NB-4622.9 establishes requirements for temper bead repairs to P-No. 1 and P-No. 3 materials and A-Nos. 1, 2, 10, or 11 filler metals. The subparagraph does not apply in this case because the proposed repairs will involve F-No. 43 filler metals.

NB-4622.10 establishes requirements for repair welding to cladding after PWHT. The subparagraph does not apply in this case because the proposed repair alternative does not involve repairs to cladding.

NB-4622.11 discusses temper bead weld repair to dissimilar metal welds or buttering and would apply to the proposed repairs as follows:

Sub-subparagraph NB-4622.11(a) requires surface examination prior to repair in accordance with NB-5000 (NB-4622.11(d)(3)). The proposed alternative will include surface examination prior to repair consistent with NB-5000.

Sub-subparagraph NB-4622.11(b) contains requirements for the maximum extent of repair. The proposed alternative includes the same limitations on the maximum extent of repair.

Sub-subparagraph NB-4622.11(c) discusses the repair welding procedure and welder qualification in accordance with ASME Section IX and the additional requirements of Article NB4000. The proposed alternative will satisfy these requirements. In addition, NB-4622.11(c) requires the Welding Procedure Specification include the following requirements:

NB-4622.11(c)(1) requires the area to be welded be suitably prepared for welding in accordance with the written procedure to be used for the repair. The proposed alternative will satisfy this requirement.

NB-4622.11(c)(2) requires the use of the shielded metal arc welding (SMAW) process with covered electrodes meeting either the A-No. 8 or F-No. 43 classifications. The proposed alternative utilizes GTAW with bare electrodes meeting either the A-No. 8 or F-No. 43 classifications.

NB-4622.11(c)(3) discusses requirements for covered electrodes pertaining to hermetically sealed containers or storage in heated ovens. These requirements do not apply because the proposed alternative uses bare electrodes that do not require storage in heated ovens since bare electrodes will not pick up moisture from the atmosphere.

NB-4622.11(c)(4) discusses requirements for storage of covered electrodes during repair welding. These requirements do not apply because the proposed alternative utilizes bare electrodes, which do not require any special storage conditions to prevent the pickup of moisture from the atmosphere.

NB-4622.11(c)(5) requires preheat to a minimum temperature of 350 °F prior to repair welding. The proposed ambient temperature temper bead alternative does not require elevated temperature preheat.

NB-4622.11(c)(6) establishes requirements for electrode diameters for the first, second, and subsequent layers of the repair weld and requires removal of the weld bead crown before deposition of the second layer. Because the proposed alternative uses weld filler metal much smaller than the 3/32, 1/8, and 5/32 inch electrodes required by NB4622.11(c)(6), the requirement to remove the weld crown of the first layer is unnecessary and the proposed alternative does not include the requirement.

NB-4622.11(c)(7) requires the preheated area to be heated from 450 °F - 660 °F for a period of at least 4 hours. The proposed alternative does not require this heat treatment because the use of the extremely low hydrogen GTAW temper bead procedure does not require the hydrogen bake-out.

NB-4622.11(c)(8) requires welding subsequent to the hydrogen bake-out of NB4622.11(c)(7) be done with a minimum preheat of 100 °F and maximum interpass temperature of 350 °F. The proposed alternative limits the interpass temperature to 350 °F and requires the area to be welded be at least 50 °F prior to welding. These limitations have been demonstrated to be adequate to produce sound welds.

NB-4622.11(d)(1) requires a liquid penetrant examination after the hydrogen bake-out described in NB-4622.11(c)(7). The proposed alternative does not require the hydrogen bake-out nor does it require the in-process liquid penetrant examination.

NB-4622.11(d)(2) requires liquid penetrant and radiographic examinations of the repair welds after a minimum of 48 hours at ambient temperature. Ultrasonic inspection is required if practical. The proposed alternative includes the requirement to inspect after a minimum of 48 hours at ambient temperature. The geometry of the RPV head and the orientation of the inner bore of the CRDM nozzles make effective radiographic examination impractical. The thickness of the RPV head limits the sensitivity of the detection of defects in the new pressure boundary weld. The density changes between the base and weld metal, and residual radiation from the base metal would render the film image inconclusive. Therefore, examinations by the ultrasonic method will be used in lieu of examinations by the radiographic method defined by IWA-4533.

NB-4622.11(e) establishes the requirements for documentation of the weld repairs in accordance with NB-4130. The proposed alternative will comply with that requirement.

NB-4622.11(f) establishes requirements for the procedure qualification test plate. The proposed alternative complies with those requirements, except that the root width and included angle of the cavity are stipulated to be no greater than the minimum specified for the repair. In addition, the location of the V-notch for the Charpy test is more stringently controlled in the proposed alternative than in NB-4622.11(f).

NB-4622.11(g) establishes requirements for welder performance qualification relating to physical obstructions that might impair the welder's ability to make sound repairs which is particular pertinent to the SMAW manual welding process. The proposed alternative involves a

machine GTAW process and requires welding operators be qualified in accordance with ASME Section IX. The use of a machine process eliminates concern about obstructions, which might interfere with the welder's abilities since these obstructions will have to be eliminated to accommodate the welding machine.

Based on the above discussions, the staff has determined that the proposed alternative to use the ambient temperature temper bead process in lieu of the code-required temper bead process will produce sound, permanent repair welds to assure adequate structural integrity, and that compliance with the specified Code requirements would result in hardship or difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the proposed alternative is acceptable.

For the repair welds, the licensee stated that in lieu of the progressive surface examinations required by subparagraph NB-4453.4 and paragraph NB-5245, the examination of the repair weld will include liquid penetrant and ultrasonic examinations. ASME Section III, 1992 Edition paragraph NB-5245 gives the NDE requirements for partial penetration welds. The requirements are to conduct progressive magnetic particle or liquid penetrant examinations. The finished surface is also to be examined by one of these methods. However, the licensee has proposed to eliminate the progressive surface examinations and to conduct a surface examination and a ultrasonic test (UT) examination of the finished surface after the completed weld has been at ambient temperature for at least 48 hours. The staff finds that the progressive examinations would be difficult to conduct because of interferences caused by the presence of the automatic GTAW welding equipment. The surface examinations will identify any surface penetrating flaws. The UT examinations should find construction and repair-related flaws when performed using appropriately qualified processes and personnel.

The staff has concluded that NB-5245 is not the appropriate code section that applies to the repair since the weld configuration is not that of a partial penetration weld. The repair weld is actually a specially designed pressure boundary, structural weld used to reestablish the pressure boundary between the CRDM nozzle and RPV head. The weld configuration is not addressed by the ASME Code. For analysis purposes, the licensee has evaluated the weld to meet the structural requirements of a partial penetration weld, and for integrity purposes, the weld is surface and volumetrically examined. The staff has determined that the proposed surface and volumetric examinations of the repair welds are acceptable.

IWA-4710(a) and IWA-5214 state that after a repair weld is made on a pressure retaining boundary or the installation of a replacement by welding, a system hydrostatic test shall be performed in accordance with IWA-5000. The licensee has proposed to perform a system leakage test in lieu of the system hydrostatic test, similar to that which is described in Code Case N-416-1 for ISI requirements. The NRC has endorsed the use of Code Case N-416-1. One of the conditions imposed by Code Case N-416-1 for use of a system leakage test is that the NDE requirements of the applicable subsection of ASME, Section III, 1992 Edition be met. Since the weld configuration of the proposed weld is not addressed in Section III, no Code-required nondestructive examination (NDE) can be referenced, and therefore, the proposed NDE is acceptable for this purpose. Therefore, based on the arguments about the acceptability of the licensee's proposed alternative to NB-5245 as discussed in the preceding paragraphs, the staff finds the performance of a system leakage test as proposed by the licensee to be an acceptable alternative to the Code-required post-repair system hydrostatic test.

Based on the above evaluation, the staff finds that compliance with the Code-required in-process and post-repair examination requirements would result in hardship or difficulty without a compensating increase in the level of quality and safety, and that the licensee's proposed alternative to perform post-repair surface and ultrasonic examinations and a system leakage test, in lieu of the Code-required post-repair examination requirements, is acceptable. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the proposed alternative is acceptable.

Per the 1989 edition of ASME Section XI, paragraph IWB-2200(a), no preservice examination is required for repairs to the J-groove welds between the vessel head and its penetrations (Examination Category B-E). However, the NDE performed after welding will serve as a preservice examination record if one is needed in the future. Furthermore, the inservice inspection requirement from Table IWB-2500-01, "Examination Category B-E...," is a VT-2 visual inspection of the external surfaces of 25 percent of the nozzles each interval with IWB-3522 as the acceptance standard. Currently, the licensee performs visual examination, VT-2, of 100 percent of the nozzles each refueling outage. Bulletin 2001-01 and ongoing deliberations in Code committees will be monitored to determine the necessity of performing any additional or augmented inspections.

Due to the previous repairs to the Oconee Unit 1 thermocouple nozzles and CRDM nozzle 21, the Unit 2 CRDM nozzles, the Unit 3 CRDM repairs described herein, and Primary Water Stress Corrosion Cracking concerns throughout the nuclear industry, Duke is planning to replace the Oconee Units 1, 2 and 3 RPV heads. Orders for the new RPV heads have been placed. The RPV head for Unit 3 will be replaced at the end-of-cycle 20 refueling outage in the Spring of 2003.

In the interim, visual inspections of the RPV closure head will continue during any planned and forced outage. The inspection schedule is based on the service life of the repairs described herein. A Framatome ANP evaluation has determined the time for a crack to grow 75 percent through-wall in the Alloy 600 nozzle material above the repair weld. The evaluation considered CRDM nozzles both in the as-repaired condition and following abrasive water jet (AWJ) remediation. The evaluation is for initiation and crack growth due to primary water stress corrosion cracking (PWSCC). If AWJ mitigation is used, the estimated corrosion time to breach the AWJ compressive residual stress layer and the estimated crack growth time to 75 percent through-wall would yield 14.6 effective full power years (EFPY) estimated service life. The current schedule includes AWJ for the Oconee Unit 3 CRDM repairs.

Flaw growth rates for evaluation were assumed to follow the 4 mm/year rate, which bounds any variation in flaw growth through the Alloy 600 material as a result of the weld repair.

Given these results, the proposed inspection schedules given above and the planned replacement dates for the Oconee Unit 3 RPV closure heads, the proposed alternatives to the ASME code requirements are justified.

The proposed alternatives are applicable to the repairs and examinations after repair to any Oconee Unit 3 RPV head CRDM nozzles.

2.2 Conclusion

Based on the discussion above for Relief Request No. 01-014, the staff has concluded that the proposed alternative to use the ambient temperature temper bead process will assure adequate structural integrity, and that the proposed in-process and post-repair examinations as described by the licensee, provides an acceptable alternative to the code required examinations. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) for the third 10 year interval.

3.0 <u>Evaluation of Flaws in the J-Groove Weld, Relief Request 01-15</u>

The Components affected by this request for relief are the 69 vessel head penetrations VHP on the RPV head of Oconee Unit 3. In its letters, the license provided the Code requirements and the licensee's basis for relief. Following is our evaluation of RR 01-15.

3.1 <u>Evaluation</u>

The repair being proposed by the licensee will move the pressure boundary from the J-Groove weld to the temper bead repair weld. The licensee conducted a finite element analysis of the penetration and proposed a maximum flaw depth of 1-3/4 inches with the flaw blunting when it enters the low alloy steel vessel material. The licensee conducted a fracture mechanics analysis and proposed that the only way that the flaw could propagate was by thermal fatigue caused by heat-up/cool-down cycles and that the flaw size would remain acceptable for 150 heat-up/cool-down cycles. The licensee evaluated the possibility of debris generation as a result of leaving the flaws in service and could not find a plausible mechanism for generating debris.

The staff has determined that examination of any flaws in the J-Groove weld region is impractical due to the configuration. The angle of incidence from the outer surface of the closure head base material does not permit perpendicular interrogation by ultrasonic shear wave techniques of circumferentially oriented flaws and the physical proximity of the nozzle does not allow for longitudinal scrutiny of the area of interest. Cladding will provide an acoustic interface which will severely limit a confident examination of the weld material. Radiography of this area is impractical due to orientation of circumferentially oriented flaws being perpendicular to gamma and x-rays. Dye penetrant and magnetic particle examination will not provide useful volumetric information since these are surface techniques.

IWA-3300(a) of the ASME Code states that flaws detected by the preservice and inservice examinations shall be sized by the bounding rectangle or square for the purpose of description and dimensioning. IWA-3300(b) of the ASME Code states that flaws shall be characterized in accordance with IWA-3310 through IWA-3390, as applicable. IWB-3132.4(a) of the ASME Code states that components whose volumetric or surface examination reveals flaws that exceed the acceptance standards listed in Table IWB-341 0-1 shall be acceptable for service without the flaw removal, repair, or replacement if an analytical evaluation, as described in IWB3600, meets the acceptance criteria of IWB-3600. In the case of the as-left J-Groove weld, the licensee has performed an analytical evaluation for a flaw based on the worst case assumptions.

IWB-3132.4(b) of the ASME Code states where the acceptance criteria of IWB-3600 are satisfied, the area containing the flaw shall be subsequently reexamined in accordance with IWB-2420(b) and (c). IWB-2420(b) states if the flaw indications or relevant conditions are

evaluated in accordance with IWB-3132.4 or IWB-3142.4, respectively, and the component qualifies as acceptable for continued service, the areas containing such flaw indications or relevant conditions shall be reexamined during the next three inspection periods listed in the schedules of the inspection programs of IWB-2410. The remaining flaws (if any are present) are no longer in a pressure retaining weld and, based on industry experience, they would arrest at the junction of the clad, ferritic metal interface. The licensee has analyzed the flaw as acceptable for continued service based on the flaw growing to this size. Successive nondestructive examination would not provide any meaningful information as far as characterizing the flaws based on the impracticality of the examination as described before. Compliance with the specified requirements is impractical.

Due to the previous repairs to the Oconee Unit 1 thermocouple nozzles and CRDM nozzle 21, the Unit 2 CRDM nozzles, the Unit 3 CRDM repairs described herein, and PWSCC concerns throughout the nuclear industry, Duke is planning to replace the Oconee Units 1, 2 and 3 RPV heads. Orders for the new RPV heads have been placed. The RPV head for Unit 3 will be replaced at the end-of-cycle 20 refueling outage in the Spring of 2003.

In the interim, visual inspections of the RPV closure head will continue during any planned outage. The inspection schedule is based on the service life of the repairs described herein. A Framatome ANP evaluation has determined the time for a crack to grow 75 percent through-wall in the Alloy 600 nozzle material above the repair weld. The evaluation considered CRDM nozzles both in the as-repaired condition and following AWJ remediation. The evaluation is for initiation and crack growth due to PWSCC. If AWJ mitigation is used, the estimated corrosion time to breach the AWJ compressive residual stress layer and the estimated crack growth time to 75 percent through-wall would yield 14.6 EFPY estimated service life. The current schedule includes AWJ remediation for the Oconee Unit 3 CRDM repairs.

Flaw growth rates for evaluation were assumed to follow the 4 mm/year rate which bounds any variation in flaw growth through the Alloy 600 material as a result of the weld repair.

Given these results, the proposed inspection schedules given above and the planned replacement dates for the Oconee Unit 3 RPV closure heads, the proposed alternatives to the ASME code requirements are justified.

The proposed alternatives are applicable to the repairs and examinations to any Oconee Unit 3 RPV head CRDM nozzles.

3.2 Conclusion

Based on the discussion above for Relief Request 01-15, the staff has concluded that the proposal to not completely remove the flaws discovered in the remaining J-Groove partial penetration welds is acceptable. IWA-4310 requires that the flaws be evaluated using the appropriate flaw evaluation rules of Section XI. Since no additional inspections are planned, the flaws will not be fully characterized. Duke will use worst-case assumptions to conservatively estimate the crack extent and orientation. The postulated crack extent and orientation will be evaluated using the rules of IWB-3500. This is sufficient to provide reasonable assurance of structural integrity. NDE of the subject weld is impractical due to weld configuration and material property. Furthermore, Duke has committed to replace the reactor vessel head during

the Spring of 2003. Therefore, the licensee's proposed alternative as described in Relief Request 01-15 provides an acceptable level of quality and safety, and is authorized pursuant to 10 CFR 50.55a(a)(3)(i) for the third 10-year interval.

Principal Reviewer: J. A. Davis

Date: February 26, 2002

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