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April 2, 2009

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: Duke Energy Carolinas, LLC (Duke)
Catawba Nuclear Station, Unit 2
Docket Number 50-414
Request for Relief Number 09-CN-002
Request to Utilize Alternative to the Requirements of ASME Code Case N-638-1

Pursuant to 10 CFR 50.55a(a)(3)(i), please find attached Request for Relief 09-CN-002. This request for alternative is being submitted to obtain NRC approval to utilize an alternative to certain requirements of the subject Code Case to apply weld buildup on three of the four reactor vessel hot leg nozzles.

Enclosure 1 contains the request for alternative. Duke requests approval of this request for alternative by April 13, 2009.

There are no NRC commitments in conjunction with this request for alternative.

If you have any questions concerning this material, please call L.J. Rudy at (803) 701-3084.

Very truly yours,

James R. Morris

LJR/s

Enclosure

A047
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Enclosure 1

Request for Relief 09-CN-002

Enclosure 1

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(i)
--Alternative Provides Acceptable Level of Quality and Safety--

Duke Energy Corporation
Catawba Nuclear Station Unit 2
Relief Request 09-CN-002

REFERENCE CODE: The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME), Section XI, 1998 Edition through 2000 Addenda.

1.0 ASME Code Components Affected

The ASME Code components associated with this request are the Class 1 Reactor Pressure Vessel (RPV) hot leg nozzles. The 2B, 2C, and 2D RPV hot leg nozzles will receive weld buildup during the Catawba Nuclear Station – Unit 2 (CNS2) EOC 16 (Spring 2009) outage.

1.1 Category and System Details:

Code Class: Class 1
System Welds: Reactor Coolant System
Examination Categories:
Category B-P for reactor vessel
Code Item Numbers:
B 15.10 for pressure retaining boundary

No relief is being requested from the pressure retaining boundary testing requirements.

1.2 Component Descriptions:

This alternative is to apply weld buildup on the three reactor vessel hot leg nozzles. The applicable items and descriptions are:

Catawba Unit 2	**Description**	**Attached Safe-End Size**	**Comment**
RV Nozzle	B Loop	Nominal 29"ID with 2 5/8" wall	LAS nozzle/Alloy 82-182 weld/SS safe end
RV Nozzle	C Loop	Nominal 29"ID with 2 5/8" wall	LAS nozzle/Alloy 82-182 weld/SS safe end
RV Nozzle	D Loop	Nominal 29"ID with 2 5/8" wall	LAS nozzle/Alloy 82-182 weld/SS safe end

1.3 Component Materials:

1. Low Alloy Steel (LAS) nozzles are SA-508 Class 2 (P-3).

2.0 <u>Applicable Code Edition and Addenda</u>

Catawba Nuclear Station – Unit 2 (CNS2) is currently in the third 10-year Inservice Inspection (ISI) interval. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) of record for the current 10-year ISI interval is Section XI, 1998 Edition through 2000 Addenda (Reference 1). This is also the edition used for the Repair/Replacement Program.

3.0 <u>Applicable Code Requirement</u>

ASME Boiler and Pressure Vessel Code, Section XI, 1998 Edition through 2000 Addenda, Article IWA-4000, "Repair/Replacement Activities"

ASME Section XI, Division 1 Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique"

ASME Boiler and Pressure Vessel Code, Section III, 1974 Edition, no Addenda for Catawba Unit 2 Class 1 piping

ASME Boiler and Pressure Vessel Code, Section III, 1971 Edition through Winter 1972 Addenda for Catawba Unit 2 Reactor Vessel design and fabrication

ASME Boiler and Pressure Vessel Code, Section III, 1989 Edition No Addenda – Duke Welding Program for all units at all sites

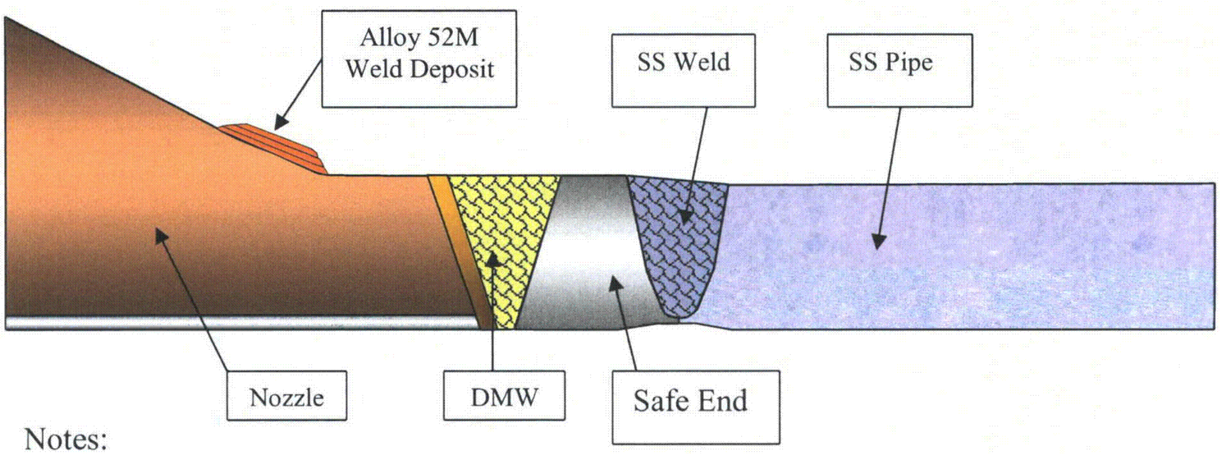
4.0 <u>Reason for Request</u>

Duke previously proposed to perform pre-emptive mitigation of the RPV hot leg nozzle dissimilar metal welds for the EOC 16 (Spring 2009) outage. During implementation Duke decided to suspend this mitigation and implement qualified ultrasonic examinations (UT) to satisfy industry commitments. To facilitate a qualified examination any applied weld deposit over the dissimilar metal weld (DMW) must be removed to allow access from the outside diameter (OD). To minimize excessive personnel dose, it is desirable to leave a portion of the deposited weld metal on the external surface of the RPV nozzle.

ASME Code Section XI, 1998 Edition through 2000 Addenda and Code Case N-638-1 provide rules for the application of weld metal utilizing the temperbead technique. This Code Case has been conditionally approved by the NRC for use; however it contains several limitations that if implemented would cause additional dose. Therefore, Duke proposes the following alternative.

5.0 Proposed Alternative

Pursuant to 10CFR 50.55a (a) (3) (i), an alternative to certain requirements listed in Section 3.0 above is requested on the basis that the proposed alternative will provide an acceptable level of quality and safety. Attachment 1, included as a part of this request for relief, provides details of relief requested from each of these requirements.



Notes:
1. Cast SS Pipe is SA-351 CF 8A (P-8).
2. Safe end is SA-182 Type 316 (P-8).
3. LAS Nozzle is SA-508 Class 2 (P-3).

Figure 1. Schematic Configuration for RPV Hot Leg Nozzle at Catawba Unit 2 (Loops B, C, and D)

6.0 Basis for Use

The weld buildup will meet applicable design rules of ASME Section XI and the Construction Code as required by IWA-4000. Welding and examination requirements for the weld deposits will meet the requirements of ASME Code Case N-638-1 with the exceptions discussed in Attachment 1. Based on the following discussion, the alternative provides an acceptable level of quality and safety.

Suitability of Proposed Ambient Temperature Temper Bead Technique

The weld buildup addressed by this Relief Request will be performed using ambient temperature temper bead welding in lieu of Post Weld Heat Treatment, in accordance with Reference 5. Research by the Electric Power Research Institute (EPRI) and other organizations on the use of an ambient temperature temper bead process using the machine Gas Tungsten Arc Welding (GTAW) process is documented in EPRI Report GC-111050 (Reference 3). According to the EPRI report, repair welds performed with an ambient temperature temper bead procedure utilizing the machine GTAW welding process exhibit mechanical properties equivalent to or better than those of the surrounding base material. Laboratory testing, analysis, successful procedure qualifications, and successful repairs have all demonstrated the effectiveness of this process.

The effects of the ambient temperature temper bead welding process on mechanical properties of repair welds, hydrogen cracking, cold restraint cracking, and extent of weld deposit coverage of ferritic base metal are addressed in the following paragraphs.

Mechanical Properties

The principal reason to preheat a component prior to repair welding is to minimize the potential for cold cracking. The two cold cracking mechanisms are hydrogen cracking and restraint cracking. Both of these mechanisms occur at ambient temperature. Preheating slows down the cooling rate resulting in a ductile, less brittle microstructure thereby lowering susceptibility to cold cracking. Preheat also increases the diffusion rate of monatomic hydrogen that may have been trapped in the weld during solidification. As an alternative to preheat, the ambient temperature temper bead welding process utilizes the tempering action of the welding procedure to produce tough and ductile microstructures. Because precision bead placement and heat input control are utilized in the machine GTAW process, effective tempering of weld heat affected zones is possible without the application of preheat. According to Section 2-1 of EPRI Report GC 111050, "the temper bead process is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered heat affected zone such that the desired degree of carbide precipitation (tempering) is achieved. The resulting microstructure is very tough and ductile."

The IWA-4630 temper bead process also includes a postweld soak requirement. Performed at 300°F for 4 hours (P-No. 3 base materials), this postweld soak assists diffusion of any remaining hydrogen from the repair weld. As such, the postweld soak is a hydrogen bake-out and not a postweld heat treatment as defined by the ASME Code. At 300°F, the postweld soak does not stress relieve, temper, or alter the mechanical properties of the weldment in any manner.

The alternative establishes detailed welding procedure qualification requirements for base materials, filler metals, restraint, impact properties, and other procedure variables. The qualification requirements provide assurance that the mechanical properties of repair welds will be equivalent to or superior to those of the surrounding base material.

Hydrogen Cracking

Hydrogen cracking is a form of cold cracking. It is produced by the action of internal tensile stresses acting on low toughness heat affected zones. The internal stresses are produced from localized build-ups of monatomic hydrogen. Monatomic hydrogen forms when moisture or hydrocarbons interact with the welding arc and molten weld pool. The monatomic hydrogen can be entrapped during weld solidification and tends to migrate to transformation boundaries or other microstructure defect locations. As concentrations build, the monatomic hydrogen will recombine to form molecular hydrogen – thus generating localized internal stresses at these internal defect locations. If these stresses exceed the fracture toughness of the material, hydrogen induced cracking will occur. This form of cracking requires the presence of hydrogen and low toughness materials. It is manifested by intergranular cracking of susceptible materials and normally occurs within 48 hours of welding.

IWA-4630 establishes elevated preheat and postweld soak requirements. The elevated preheat temperature of 300°F increases the diffusion rate of hydrogen from the weld. The postweld soak at 300°F was also established to bake-out or facilitate diffusion of any remaining hydrogen from the weldment. However, while hydrogen cracking is a concern for Shielded Metal Arc Welding (SMAW), which uses flux covered electrodes, the potential for hydrogen cracking is significantly reduced when using the machine GTAW process.

The machine GTAW process is inherently free of hydrogen. Unlike the SMAW process, GTAW filler metals do not rely on flux coverings that may be susceptible to moisture absorption from the environment. Conversely, the GTAW process utilizes dry inert shielding gases that cover the molten weld pool from oxidizing atmospheres. Any moisture on the surface of the component being welded will be vaporized ahead of the welding torch. The vapor is prevented from being mixed with the molten weld pool by the inert shielding gas that blows the vapor away before it can be mixed. Furthermore, modern filler metal manufacturers produce wires having very low residual hydrogen. This is important because filler metals and base materials are the most realistic sources of hydrogen for the automatic or machine GTAW temper bead process. Therefore, the potential for hydrogen-induced cracking is greatly reduced by using the machine GTAW process. Extensive research has been performed by EPRI (Reference 4) which provides a technical basis for starting the 48-hour hold after completing the third temper bead weld layer rather than waiting for all weld deposit to cool to ambient temperature. This approach has been previously reviewed and approved by the NRC for pressurizer and hot leg surge nozzle overlays.

Cold Restraint Cracking

Cold cracking generally occurs during cooling at temperatures approaching ambient temperature. As stresses build under a high degree of restraint, cracking may occur at defect locations. Brittle microstructures with low ductility are subject to cold restraint cracking. However, the ambient temperature temper bead process is designed to provide a sufficient heat inventory so as to produce the desired tempering for high toughness. Because the machine GTAW temper bead process provides precision bead placement and control of heat, the toughness and ductility of the heat affected zone will typically be superior to the base material. Therefore, the resulting structure will be appropriately tempered to exhibit toughness sufficient to resist cold cracking.

Area Limitation

IWA-4630 and early versions of Code Case N-638 through Revision 2 for temper bead welding contained a limit of 100 square inches for the surface area of temper bead weld over the ferritic base metal. The associated limitation proposed in Attachment 1 is 500 square inches, consistent with ASME approved Code Case N-638-3. However, Code Case N-638-3 has not been approved by the NRC in Regulatory Guide 1.147 Revision 15.

An ASME white paper (Reference 2) describes the technical justification for allowing increased overlay areas up to 500 square inches. The white paper notes that the original limit of 100 square inches in Code Case N-638-1 was arbitrary. It cites evaluations of a 12 inch diameter nozzle weld overlay to demonstrate adequate tempering of the weld heat affected zone (Section 2a of the white paper), residual stress evaluations demonstrating acceptable residual stresses in weld overlays ranging from 100 to 500 square inches (Section 2b of the white paper), and service history in which weld repairs exceeding 100 square inches were NRC approved and applied to DMW nozzles in several BWRs and PWRs (Section 3c of the white paper). Some of the cited repairs are greater than 15 years old, and have been inspected several times with no evidence of any continued degradation.

It is important to note that the above theoretical arguments and empirical data have been verified in practice by extensive field experience with temper bead weld overlays, with ferritic material coverage ranging from less than 10 square inches up to and including 325 square inches. Table 1 below provides a partial list of such applications. It is seen from this table that the original DMW weld overlay was applied over 20 years ago, and WOLs with low alloy steel (LAS) coverage in the 100 square inch range have been in service for 5 to 15 years. Several overlays have been applied with LAS coverage significantly greater than the 100 square inches. Relief requests for these large overlays have been previously approved. These overlays have been examined with PDI qualified techniques, in some cases multiple times, and none have shown any signs of new cracking or growth of existing cracks.

7.0 Duration of Proposed Alternative

This proposed alternative is for application as needed during the remainder of the current Catawba Nuclear Station – Unit 2 (CNS2) third inspection interval which ends August 19, 2016.

8.0 Implementation

The weld deposit will be installed during the Catawba Nuclear Station – Unit 2 (CNS2) EOC 16 (Spring 2009) outage. NRC approval is requested by 04/13/2009, to support the schedule for completion of activities during the outage.

9.0 Precedents

Similar requests have been submitted to address the issues that are contained in this request. The technical approach and basis for the proposed alternative in this request is similar to the request from Duke Energy Corporation's McGuire Nuclear Station Unit 1 and Catawba Nuclear Station Unit 2 for application of FSWOLs to their pressurizer nozzle DMWs in letter titled "Duke Power Company LLC d/b/a Duke Energy Carolinas, LLC, (Duke) McGuire Nuclear Station, Unit 1 Docket Number 50-369 Catawba Nuclear Station, Unit 2 Docket Number 50-414 Relief Request 07-GO-001" (ADAMS Accession Number ML070310367), dated January 24, 2007. This relief request was approved by the NRC through the NRC Letter to Duke, Catawba Nuclear Station, Unit 2, and McGuire Nuclear Station, Unit 1, Relief 07-GO-001 for Use of Preemptive Weld Overlay and Alternative Examination Techniques on Safe End Welds (TAC Nos. MD4671 and MD4672), November 27, 2007.

Similar relief requests were also previously submitted by Progress Energy's Crystal River Nuclear Plant, South Carolina Electric and Gas's Virgil C. Summer Station, and by Entergy for Arkansas Nuclear One. These requests were approved by the NRC through the NRC Letter to Progress Energy's Crystal River Nuclear Plant, Unit 3, Relief Request #08-001-RR, Revision 1, to Install a Weld Overlay on the Dissimilar Metal Weld in the Decay Heat Drop Line (TAC NO. MD 8237) May 22, 2008; NRC letter to South Carolina Electric and Gas, Virgil C. Summer Nuclear Station, Unit 1, Proposed Alternative for the Application of Weld Overlay on Dissimilar Metal Welds of Pressurizer Nozzles (TAC NO. MD5665), March 25, 2008; and NRC letter to Entergy, Arkansas Nuclear One, Unit 1 – Request for Alternative to the American Society of

Mechanical Engineers Boiler and Pressure Vessel Code Requirements for Pressurizer Nozzle Weld Overlay Repairs (TAC NO. MD4019), April 6, 2007, respectively.

10.0 References

1. The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME), Section XI, 1998 Edition through 2000 Addenda.
2. "Justification for the Removal of the 100 Square Inch Limitation for Ambient Temperature Temper Bead Welding on P-3 Material", EPRI-NP-1011898, February 2005.
3. "Ambient Temperature Preheat for Machine GTAW Temperbead Applications", EPRI Report GC-111050, November 1998.
4. "Temperbead Welding Applications – 48 hour Hold for Ambient Temperature Temperbead Welding", EPRI Report 1013558, December 2006.
5. ASME Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique."

Table 1. Recent Overlay Experience

Date	Plant	Component	Nozzle Diameter (in)
December 2007	SCE/SONGS 2	PZR surge nozzle	12
November 2007	Duke/Oconee 3	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 4.5 10
November 2007	APS / Palo Verde 3	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 12
October 2007	SCE/SONGS 3	PZR surge nozzle	12
October 2007	Duke / Catawba 2	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
October 2007	PSEG/Hope Creek	Recirc Inlet nozzle	10
October 2007	TVA Sequoyah 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 12
October 2007	Tai Power / Kuosheng 2	Recirc Inlet nozzle	10
September 2007	Progress / Harris	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
June 2007	APS / Palo Verde 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 12
May 2007	Entergy / ANO 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 4.5 10
May 2007	Duke / Oconee 2	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 4.5 10
April 2007	Duke / McGuire 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
April 2007	STPNOC / South Texas 2	PZR spray nozzle safety/relief nozzles PZR surge nozzle	6 6 16
March 2007	FPL / Duane Arnold	Recirc. Inlet nozzles	10
March 2007	TPC / Chin Shan	Recirc Outlet nozzle	23
March 2007	Entergy / Pilgrim	Recirc. Inlet nozzle	10
December 2006	TVA/Sequoyah 2	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
November 2006	SCE/SONGS Unit 3	PZR spray nozzle safety/relief nozzles PZR surge nozzle	5.1875 8 12.75

Table 1. Recent Overlay Experience (concluded)

Date	Plant	Component	Nozzle Diameter (in)
November 2006	Duke/Catawba Unit 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
November 2006	Duke/Oconee Unit 1	PZR spray nozzle safety/relief nozzles PZR surge nozzle HL Surge Nozzle	4.5 4.5 10.875 10.75
October 2006	Duke/McGuire Unit 2	PZR spray nozzle safety/relief nozzles PZR surge nozzle	4 6 14
April 2006	FENOC/Davis Besse	Hot leg drain nozzle	4
February 2006	SCE/SONGS Unit 2	PZR spray nozzle safety/relief nozzles	8 6
November 2005	TPC/Kuosheng Unit 2	Recirculation outlet nozzle	22
April 2004	PPL/Susquehanna Unit 1	Recirc. inlet nozzle Recirc. outlet nozzle	12 28
November 2003	AmerGen/TMI Unit 1	Surge line nozzle	11.5
October 2003	Entergy/Pilgrim	Core spray nozzle CRD return nozzle	10 5
October 2002	Exelon/Peach Bottom Units 2 & 3	Core spray nozzle Recirc. outlet nozzle CRD return nozzle	10 28 5
October 2002	AmerGen/Oyster Creek	Recirc. outlet nozzle	26
December 1999	FPL/Duane Arnold	Recirc. inlet nozzle	12
June 1999	FENOC /Perry	Feedwater nozzle	12
June 1998	CEG/Nine Mile Point Unit 2	Feedwater nozzle	12
March 1996	Progress/Brunswick Units 1 & 2	Feedwater nozzle	12
February 1996	Southern/Hatch Unit 1	Recirc. inlet nozzle	12
January 1991	Entergy/River Bend	Feedwater nozzle	12
March 1986	Entergy/Vermont Yankee	Core spray nozzle	10

ATTACHMENTS

Attachment 1
Modifications to Code Case N-638-1

Attachment 1

Modifications to Code Case N-638-1

Code Case N-638-1	Modification/Basis
Weld Area 1.0(a) The maximum area of an individual weld based on the finished surface shall be 100 sq. inch, and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.	**Modification:** The maximum area of an individual weld based on the finished surface ***over the ferritic material*** will not exceed 500 square inches, and the depth of the weld deposit shall not be greater than one-half of the ferritic base m*etal thickness* **Basis:** *The maximum area of the weld deposit for the RPV nozzle will be approximately 500 square inches over the ferritic material. Justification for extending the area limitation to 500 square inches is based on the overall conclusions of EPRI Report NP-1011898 as discussed in Section 6.0 of this Relief Request.*
Examination (Referenced below in 4.0(b) para. 1.0(d) Prior to welding the area to be welded and a band around the area of at least 1.5 times the component thickness or 5 inch, whichever is less shall be at least 50°F.) 4.0(b) The final weld surface and a band around the area defined in para. 1.0 (d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I.[3] ——— [3]Refer to the 1989 Edition with the 1989 Addenda and later Editions and Addenda	**Modification:** The required liquid penetrant examination of 4.0(b) will be performed on the weld deposit. The ultrasonic examination will be in accordance with ASME Section XI, Appendix I. **Basis:** *For the application of the weld deposit addressed in this request the examination methodologies will conform to Appendix I. Code Case N-638-3 has eliminated the requirement to examine a band around the area to be welded, and specifies required post weld nondestructive examination of the welded region only. This Code Case applies to any type of welding where a temper bead technique is to be employed and is not specifically written for a weld build up. Further revision to this Code Case has clarified this. For this application, it is believed that any major base material cracking would take place in the HAZ directly below the weld deposit and not in the band of material out beyond the deposit. Therefore, the ultrasonic examination of the weld deposit would identify if this cracking were to occur.*

4.0(c) requires temperature monitoring by welded thermocouples per IWA-4610(a)	***Modification:*** *Preheat and interpass temperatures for the weld pad will be measured on a test coupon that is equal to or less than the thickness of the item to be welded. The maximum heat input of the welding procedure shall be used in the welding of the test coupon.* ***Basis:*** *Code Case N-638-3 has expanded the options for meeting this requirement. Due to the location of the repair and area radiation dose rate, the placement of welded thermocouples for monitoring weld interpass temperature is determined to be not beneficial based on dose savings. Therefore, welded thermocouples are not planned for use to monitor interpass temperature during welding.*