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

July 14, 2011

Mr. J. R. Morris
Site Vice President
Catawba Nuclear Station
Duke Energy Carolinas, LLC
4800 Concord Road
York, SC 29745

SUBJECT: CATAWBA NUCLEAR STATION, UNIT 2 – RELIEF 10-CN-001, ALTERNATIVE REQUIREMENTS FOR TEMPORARY ACCEPTANCE OF A THROUGH-WALL FLAW IN BORIC ACID TANK NOZZLE WELD (TAC NO. ME4458)

Dear Mr. Morris:

By letter dated July 22, 2010, as supplemented by letter dated March 30, 2011, Duke Energy Carolinas, LLC, (the licensee), submitted relief request (RR) 10-CN-001 for Catawba Nuclear Station, Unit 2 (Catawba 2), related to the use of an alternative to the requirements of the American Society of Mechanical Engineers, *Boiler and Pressure Vessel Code* (ASME Code), Section XI. The licensee proposed an alternative and requested relief from the repair and/or replacement activity requirements of the ASME Code, Section XI. The request for relief pertains to the necessity to perform an immediate, code-compliant repair of a through-wall leak in the nozzle-to-shell weld of boric acid tank nozzle of the chemical and volume control system at Catawba 2. The proposed alternative delayed this repair until the next scheduled refueling outage for Catawba 2 (2EOC17, which ended in the fall of 2010) and provided for additional inspection and monitoring of the weld area until that time. During the acceptance review for this relief request, the Nuclear Regulatory Commission (NRC) staff found no safety issues that would prevent the continuation of its review. During the preparation of this safety evaluation, the licensee completed code-compliant repairs to this weld during the Catawba 2 refueling outage completed in the fall of 2010.

The NRC staff has reviewed the licensee's submittal and, based on the information provided in the licensee's request for relief, the NRC staff has determined that the proposed alternative would provide reasonable assurance of operational readiness of the chemical and volume control (NV) system and requiring an ASME Code repair immediately after determining the leak could have resulted in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to Title 10 of the Code of Federal Regulations, Part 50, paragraph 50.55a(a)(3)(ii), the NRC staff authorizes the licensee's proposed alternative at Catawba 2 until an ASME Code, Section XI, repair and/or replacement which was performed during the next scheduled Catawba 2, refueling outage (2EOC17) in the fall of 2010.

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

Sincerely,

Patrick G Boyle for

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

Docket No. 50-414

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF NO. 10-CN-001

"ALTERNATIVE REQUIREMENTS FOR TEMPORARY ACCEPTANCE OF A

THROUGH-WALL FLAW IN BORIC ACID TANK NOZZLE WELD"

DUKE ENERGY CAROLINAS, LLC

CATAWBA NUCLEAR STATION, UNIT 2

DOCKET NO. 50-414

1.0 INTRODUCTION

By letter dated July 22, 2010, (Agencywide Documents Access and Management System, (ADAMS) Accession No. ML102110043), as supplemented by letter dated March 30, 2011, (ADAMS Accession No. ML111020307), Duke Energy Carolinas, LLC, (Duke, the licensee), submitted relief request (RR) 10-CN-001 for Catawba Nuclear Station, Unit 2 (Catawba 2), related to the use of an alternative to the requirements of the American Society of Mechanical Engineers, *Boiler and Pressure Vessel Code* (ASME Code), Section XI. The licensee proposed an alternative to, and requested relief from, the repair and/or replacement activity requirements of the ASME Code, Section XI. The request for relief pertains to the necessity to perform an immediate, code-compliant repair of a through-wall leak in the nozzle-to-shell weld of boric acid tank nozzle of the chemical and volume control system at Catawba 2. The proposed alternative delayed this repair until the next scheduled refueling outage for Catawba 2 (2EOC17, which ended in the fall of 2010) and provided for additional evaluation and inspection of the weld area until that time. During the acceptance review for this RR, the Nuclear Regulatory Commission (NRC) staff found no safety issues that would prevent the continuation of its review. During the preparation of this safety evaluation (SE), the licensee completed code-compliant repairs to this weld during the Catawba 2 refueling outage completed in fall 2010.

On April 2, 2010, evidence of leakage of borated water (i.e., approximately 1-inch diameter patch of dried boron) was detected at the bottom of the nozzle Mk. "M" nozzle-to-shell weld on the Catawba 2 boric acid tank. The licensee characterized the leakage as "negligible." The licensee acknowledged that prior to continued service Section IWB 3522.1 of the ASME Code requires that a component whose visual examination (IWA-5240) detects "discoloration or accumulated residues on surfaces of components, insulation, or floor areas that may be evidence of borated water leakage" shall meet IWB-3142 and IWA-5250 prior to continued service.

Enclosure

Due to the fact that the leak was "negligible," the licensee requested relief from the requirements of IWB 3522.1 and proposed to make permanent repairs to the weld during the next scheduled refueling outage for Catawba 2, 2EOC17 which ended in the fall of 2010. During the acceptance review for this RR, the NRC staff found no safety issues that would prevent the continuation of its review. During the preparation of this SE, the licensee completed code-compliant repairs to this weld during refueling outage 2EOC17 for Catawba 2, which ended in the fall of 2010.

2.0 REGULATORY EVALUATION

Paragraph 50.55a(g)(4) of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, states that

> ... components (including supports) which are classified as ASME Code Class 1, Class 2 and Class 3 must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI of editions of the ASME *Boiler and Pressure Vessel Code* and Addenda that become effective subsequent to editions specified in paragraphs (g)(2) and (g)(3) of this section and that are incorporated by reference in paragraph (b) of this section, to the extent practical within the limitations of design, geometry and materials of construction of the components.

Paragraph 55a(a)(3) of 10 CFR, Part 50, states that

> Proposed alternatives to the requirements of paragraphs (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. The applicant shall demonstrate that:
>
> (i) The proposed alternatives would provide an acceptable level of quality and safety, or
>
> (ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The Catawba 2 ASME Code of Record for the third 10-year inservice inspection (ISI) interval, which is scheduled to end on August 19, 2016, is the 1998 Edition through 2000 Addenda of Section XI of the ASME Code.

3.0 DISCUSSION

3.1 Licensee's Observations

The licensee stated that

> On April 2, 2010, evidence of leakage was detected at the bottom of Nozzle Mk. "M" on the [Catawba] Unit 2 Boric Acid Tank. This evidence consisted of a very small (approximately 1" diameter) patch of dried boron. Through-wall leakage was confirmed in the nozzle-to-shell weld after the weld was cleaned and reinspected. The leakage rate has been characterized as negligible.

3.2 Affected ASME Code Components

ASME Code Class: Class 3
Component: Boric acid tank shell nozzle Mk. "M" nozzle-to-shell weld
System: Chemical and Volume Control (NV)

The component for which relief is requested is described below.

System / Component		Description	Component Material
Boric acid tank shell nozzle Mk. "M" nozzle-to-shell weld	Tank Shell	Nominal Thickness, ¼ inch	SA-240, TP304
	Nozzle	1 inch NPS, 3000# Threaded Full Coupling	SA-182, TP304

Nozzle Mk. "M" is located near the bottom of the boric acid tank and is connected to the tank shell using a full penetration weld with a ¼-inch fillet weld reinforcement. The weld material is ER308 stainless steel.

3.3.1 Applicable ASME Code Edition and Addenda

The code of record for the third 10-year ISI interval at Catawba 2 is the 1998 Edition through 2000 Addenda of the ASME Code, Section XI. The third 10-year ISI interval will end on August 19, 2016.

3.3.2 Actions Required By ASME Code

The ASME Code, Section XI, Article IWD 3000, "Acceptance Standards," specifies that the rules of Article IWB 3000, "Acceptance Standards," may be used. Section IWB 3522.1 of the ASME Code requires that a component whose visual examination (IWA-5240) detects "discoloration or accumulated residues on surfaces of components, insulation, or floor areas that may be evidence of borated water leakage" shall meet IWB-3142 and IWA-5250 prior to continued service. The NRC staff interprets this section of the code to require that the component exhibiting through-wall leakage, as observed by the licensee, must be replaced or repaired by a code-compliant method prior to continued operation unless relief is granted by the NRC staff.

3.4 Hardship or Unusual Difficulty

The licensee stated that

> Compliance with the requirement of IWB-3522.1 would require that a repair be made to the Boric Acid Tank Mk. "M" nozzle-to-shell weld prior to returning the component to

service. Because the flaw was identified during plant operation, compliance with IWB-3522.1 would require that the Boric Acid Tank be immediately removed from service in order to make the necessary repairs.

Making this repair immediately constitutes a hardship in the view of the licensee, and it has, therefore, requested relief from this code requirement. The licensee stated that

> ... it would be difficult to complete the necessary repairs during plant operation because the Boric Acid Tank will have to be drained and the contents (approximately 42,000 gallons) transferred to temporary storage, which is limited during plant operation. Performing these actions will require the development of temporary procedures because existing procedures do not address draining, transferring and temporary storage of tank contents, and refilling of the Boric Acid Tank from temporary storage during plant operation.

Additionally, the licensee believes that immediate repair of the leaking weld was not necessary and stated the following in support of this conclusion:

1. Nozzle Mk. "M" is used for the installation of a thermowell. As such, the external loads on this nozzle are negligible, and pressure loads are small (approximately 3.6 psi [pounds per square inch] due to internal pressure from the static head of the water in the tank).

2. The stress intensity in the nozzle-to-shell weld from the applied loads is not sufficient to support crack growth in this material, which has a relatively high fracture toughness.

3. Liquid penetrant (PT) and visual examinations were performed on the Mk. "M" nozzle weld on April 6, 2010. The PT examinations confirmed the existence of two, 1/16" rounded indications near the 7 O'clock position on the weld. These indications satisfied the ASME Code, Section XI acceptance standards based on their size.

4. All other accessible external welds on the [Catawba] Units 1 and 2, Boric Acid Tanks were visually examined on April 27, 2010, and evidence of leakage was not detected at any other locations. The results of these examinations support Duke Energy's position that the through-wall leakage on the [Catawba] Unit 2 Mk. "M" nozzle-to-shell weld is likely the result of a fabrication defect. The indications are small and satisfy the acceptance standards for [ASME] Section XI surface examination. For these reasons, Duke Energy does not believe that the through-wall leakage is the result of service-induced degradation.

5. The proposed alternative visual examinations are judged sufficient to monitor the leakage from this weld to ensure that flaw growth does not occur. A significant increase in the observed leakage will require an Engineering evaluation to be performed to ensure that the condition does not challenge the structural integrity of the nozzle weld.

3.5 Licensee's Proposed Alternative (as stated)

In lieu of the requirement of [ASME Code, Section XI,] IWB 3522.1 to correct the degraded condition prior to continued service, Duke Energy requests NRC approval to allow continued operation of the Boric Acid Tank until such time that an ASME Code, Section XI repair/replacement activity can be performed in accordance with IWA-4000. The following alternative requirements are proposed:

1. A visual examinations of Nozzle Mk. "M" shall be performed weekly during Operations rounds to confirm that the leakage from the nozzle Mk. "M" weld has not increased significantly.

2. If a significant increase in leakage is detected during the visual examination (i.e., boric acid deposit with accumulated volume greater than 1 in^3 over the weekly inspection period or active, visible leakage), an Engineering evaluation shall be performed to confirm the continued structural integrity of the nozzle weld.

3. If the Engineering evaluation determines that the structural integrity of the connecting weld can no longer be assured, the [Catawba] Unit 2, Boric Acid Tank shall be declared "non functional" and actions would be taken in accordance with applicable licensing commitments.

3.6 Duration of Relief

RR 10-CN-001 was submitted for approval until an ASME Code, Section XI, repair and/or replacement is performed during the next scheduled Catawba 2 refueling outage, 2EOC17, which ended in the fall of 2010.

3.7 Permanent Repair to the Leaking Weld

By letter dated March 30, 2011, the licensee submitted responses to the NRC staff's requests for additional information. In those responses the licensee confirmed that permanent repairs to the leaking weld had been completed during refueling outage 2EOC17 which ended in the fall of 2010. This fulfilled the requirements of the licensee's proposed alternative, and, since all code requirements were now met, eliminated the need for continued relief.

In its responses, the licensee also indicated that it had performed a root cause evaluation of the leak. The NRC staff had three significant observations derived from this root cause evaluation:

1. The leak did not originate at either of the rounded indications described above, but rather at a small crack which was not detected by the visual, or dye penetrant, examinations conducted.

2. The crack "initiated from the ID [inner diameter] surface of the nozzle" (threaded coupling) on the vessel interior and propagated through the coupling base metal and its connecting weld including the heat affected zone on the coupling).

3. The crack was caused by transgranular stress corrosion cracking which was attributed to the presence of oxygen in the tank, as well as the presence of contaminants including sulfur and chlorides.

4.0 TECHNICAL EVALUATION

The NRC staff has evaluated the information provided in RR 10-CN-001, dated July 22, 2010, as supplemented by letter dated March 30, 2011, in support of temporarily accepting through-wall leakage in an ASME Code Class 3 component in lieu of the ASME Code-required repair and/or replacement activity. In its review, the NRC staff considered three issues:

a) The acceptability of the licensee seeking relief from ASME Code, Section XI, IWB 3522.1 under 10 CFR 50.55a(a)(3)(ii), and the authority of the NRC staff to grant such relief,

b) The existence of a hardship as required by 10 CFR 50.55a(a)(3)(ii), and

c) The existence of a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair.

Based on the analysis of regulatory requirements in Section 2, "Regulatory Evaluation," of this SE, i.e., that 10 CFR 50.55a(g)(4) requires licensees to comply with the ASME Code and that 10 CFR 50.55a(a)(3) permits licensees to request, and permits the NRC staff to authorize, alternatives to the ASME Code when the licensee demonstrates that: (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The NRC staff finds that issue a) has been adequately addressed.

In evaluating issue b) above, the NRC staff considered that the licensee's statement that draining the 42,000-gallon boric acid tank constituted a hardship. The NRC staff concludes that a storage location for this water is not available while the plant is operating and that procedures for conducting this transfer during plant operation do not exist. The NRC staff, therefore, concludes that the licensee has two options, finding a storage location for this water during plant operation and developing procedures for this transfer or shutting the plant down. The NRC staff finds that these conditions would constitute a hardship and, therefore, that issue b) has been adequately addressed.

When evaluating issue c), whether there is a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair, the NRC staff considered the elements of the evaluation guideline used in Enclosure 1 to Generic Letter (GL) 90-05 (ADAMS Accession No. ML031140590). There are a number of differences between the context of application associated with this RR and that addressed by Enclosure 1 to GL 90-05. Enclosure 1 to GL 90-05 addresses piping issues, while the subject current RR addresses a pipe-to-tank connection. Enclosure 1 to GL 90-05 addresses the impracticality of compliance with the regulation, while the RR that is the subject of this SE addresses hardship without a compensating increase in the level of quality and safety. Despite these differences, the NRC staff finds that the elements of the evaluation guideline used in Enclosure 1 to GL 90-05 provide a useful framework for evaluating issues associated with this RR.

Enclosure 1 to GL 90-05 provides four elements for its evaluation guideline for determining the acceptability of the use of temporary repair techniques, including the absence of any repair until the next scheduled outage exceeding 30 days, for ASME Code Class 3 piping. (The material at issue in this SE is an ASME Code Class 3 tank shell nozzle nozzle-to-shell weld). These elements include:

a) Flaw detection during plant operation and impracticality determination,

b) Root cause determination and flaw characterization,

c) Flaw evaluation, and

d) Augmented inspection

The first element considered when evaluating issue c) above, the existence of a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair, is flaw detection during plant operation and impracticality determination. This element assumes that the initiating event is the detection of a flaw during plant operation. In the case of the material evaluated in this SE, the evidence of a leak in an ASME Code Class 3 component has been discovered during plant operation. Regarding an impracticality determination, Enclosure 1 to GL 90-05 states that

> The licensee should determine the existence of any impracticality in performing a code repair. If practical, that is, if the affected section of piping can be isolated for completing a code repair within the time period permitted by the limiting condition for operation (LCO) without a plant shutdown, the licensee is required to perform a code repair.

Whereas this element of Enclosure 1 to GL 90-05 was developed to address impracticality, the issue evaluated in this SE is "hardship or unusual difficulty without a compensating increase in the level of quality and safety." The lack of ability to isolate the affected section of piping is one measure of impracticality. In the case of this SE, isolating the affected component would represent a hardship due to the lack of procedures for transferring the liquid and the lack of other tanks to hold the liquid. As this crack was extremely small (undetectable by visual and penetrant examinations), the operating pressure of the system was very low (atmospheric pressure), and the materials involved had a high fracture toughness, there does not appear to be a compensating increase in the level of quality and safety by taking these measures. The NRC staff finds that the licensee's RR adequately addresses flaw detection and the determination of hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The second element considered when evaluating issue c) above, the existence of a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair, is the root cause determination and flaw characterization. Enclosure 1 to GL 90-05 recommends that

> The flaw geometry should be characterized by a suitable NDE [nondestructive evaluation] method for subsequent flaw evaluation. This examination should involve the application of UT [ultrasonic testing] or RT [radiographic testing] techniques.

In its initial submission dated July 22, 2010, the licensee indicated that it had performed liquid penetrant and visual exams of the area of leakage and had detected two rounded indications. The licensee did not perform NDE, UT, or RT examinations of the flaw. The licensee indicated that, other than the leakage potentially associated with these indications, they met the acceptance criteria for weld defects as specified in the ASME Code. Based on the shape of these indications, the licensee concluded that they were original fabrication defects.

In its letter dated March 30, 2011, supplementing its original submission, the licensee described its root cause evaluation which was completed after completion of repairs during refueling outage 2EOC17 in the fall of 2010. The NRC staff drew three significant observations from this root cause evaluation:

1. The leak did not originate at either of the rounded indications described above, but rather at a small crack which was not detected by the visual or dye penetrant examinations conducted.

2. The crack "initiated at the surface of the nozzle (threaded coupling) on the vessel interior and propagated through the coupling base metal and its connecting weld including the heat affected zone on the coupling).

3. The crack was a transgranular stress corrosion crack which was attributed to the presence of oxygen in the tank, as well as the presence of contaminants including sulfur and chlorides.

Based on this additional information, the NRC staff finds that there is no reason to believe that the licensee necessarily would have been able to deduce this information prior to the completion of permanent repairs and the conduct of the failure analysis. The NRC staff, therefore, finds no deficiency in the licensee's initial submittal. The NRC staff finds that the licensee's RR adequately addresses root cause determination and flaw characterization.

The third element considered when evaluating issue c) above, the existence of a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair, is flaw evaluation. To address the evaluation of the flaw, GL 90-05 provides two approaches. The first is a "through-wall flaw" fracture mechanics approach and the second is a "wall thinning" approach. In this case, the "through-wall" fracture mechanics approach is the applicable approach. In the "through-wall flaw" fracture mechanics approach, the stress intensity at the tips of the flaw is calculated and compared to the fracture toughness of the material. As long as the stress intensity of the crack is less than the fracture toughness of the material, unstable crack growth is not anticipated. In this case, the licensee stated that "The stress intensity in the nozzle-to-shell weld from the applied loads is not sufficient to support crack growth in this material ...." The NRC staff agrees with this assessment due to the nature of the observed indication and the high fracture toughness of the materials involved.

The NRC staff notes that, had the information obtained in the failure analysis been initially available, its method of considering flaw evaluation likely would have changed. However, based on the extremely small size of the crack (undetectable by visual and penetrant examinations), the very low operating pressure of the system (atmospheric pressure) and the high fracture

toughness of the materials involved, the NRC staff's conclusion regarding the ability of an immediate repair of the leak to provide a "compensating increase in the level of quality and safety" would not have changed.

The fourth element considered when evaluating issue c) above, the existence of a "compensating increase in the level of quality and safety" associated with immediately making a code-compliant repair, is augmented inspection. To address augmented inspections, GL 90-05 recommends that

> If the flaw is evaluated and found acceptable by one of the above evaluation approaches, the licensee should perform an augmented inspection via UT or RT to assess the overall degradation of the affected system.

and

> The extent of the augmented inspection depends on whether the line is high energy or moderate energy.

To address this issue, the licensee performed a visual examination of all accessible welds of the boric acid tanks. Given the very small size of the crack, the very low pressure of the boric acid tanks (atmospheric pressure), the high fracture toughness of the material, and the 100% sample employed, the NRC staff finds that the actions taken by the licensee were sufficient to adequately address this element of augmented inspection.

In addition to the above elements, GL 90-05 recommends that licensees assess the structural integrity of non-code repairs not less than once per week. The licensee's proposed alternative contains such a provision.

5.0 CONCLUSION

The NRC staff has reviewed the licensee's submittal and, based on the information provided in the licensee's request for relief, the NRC staff has determined that the proposed alternative would provide reasonable assurance of operational readiness of the chemical and volume control (NV) system and requiring an ASME Code repair immediately after determining the leak could have resulted in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes the licensee's proposed alternative at Catawba 2 until an ASME Code, Section XI, repair and/or replacement which was performed during the next scheduled Catawba 2, refueling outage 2EOC17 in the fall of 2010.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third-party review by the Authorized Nuclear In service Inspector.

Principal Contributors: A. Rezai, NRR
J. Thompson, NRR

Date: July 14, 2011

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

Sincerely,

/RA/ by PBoyle Acting for

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

Docket No. 50-414

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