August 8, 2008

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 1, REQUEST FOR RELIEF 07-CN-004, LIMITED WELD EXAMINATIONS DURING END-OF-CYCLE 16 REFUELING OUTAGE (TAC NOS. MD6774, MD6775, MD6776, MD6777, MD6778, MD6779, MD6780, MD6781, MD6782, MD6783, AND MD6784)

Dear Mr. Morris:

By letter dated August 27, 2007, Duke Energy Carolinas, LLC, the licensee, submitted a request for relief, Relief Request No. 07-CN-004, from the American Society of Mechanical Engineers (ASME), *Boiler and Pressure Vessel Code* (Code), Section XI, 1998 Edition through the 2000 Addenda requirement pertaining to limited weld examination coverage at the end of operating cycle 14 during the third 10-year Inservice Inspection (ISI) interval at Catawba Nuclear Station, Unit 1 (Catawba 1). The third 10-year interval for Catawba 1 started June 29, 2005, and ends June 29, 2015. The licensee already performed the scheduled third 10-year interval ISI on the referenced welds and components resulting in limited volumetric and visual coverage. As a result, the licensee has proposed that no alternate examinations or testing will be performed during the end of operating cycle 16 to compensate for the limited ultrasonic examination coverage.

The enclosed safety evaluation contains the Nuclear Regulatory Commission (NRC) staff's evaluation and conclusions. Based on the information provided in the licensee's request for relief, the NRC staff has determined that it is impractical for the welds identified to be examined to the extent required by the ASME Code at Catawba 1. It is further concluded that reasonable assurance of structural integrity is provided by the examinations that were performed by the licensee.

Therefore, relief is granted and requirements are imposed pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.55a(g)(6)(i) for the second 10-year ISI interval at Catawba 1 for referenced welds. Granting relief and imposing requirements are authorized by law and will not endanger life, property, or the common defense and security, and are otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility.

All other requirements of 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.

Sincerely,

/RA/

Melanie C. Wong, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-413

Enclosure:
Safety Evaluation

cc w/encl: See next page

All other requirements of 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.

Sincerely,

/RA/

Melanie C. Wong, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
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Enclosure:
Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF NO. 07-CN-004

CATAWBA NUCLEAR STATION, UNIT 1

DUKE ENERGY CAROLINAS, LLC

DOCKET NO. 50-413

1.0 INTRODUCTION

By letter dated August 27, 2007, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML073180447), Duke Energy Carolinas, LLC, the licensee, submitted a request for relief, Relief Request No. 07-CN-004, from the American Society of Mechanical Engineers (ASME), *Boiler and Pressure Vessel Code* (Code), Section XI, 1998 Edition through the 2000 addenda requirement pertaining to limited weld examination coverage at the end of operating cycle 16 during the third 10-year inservice inspection (ISI) interval at Catawba Nuclear Station, Unit 1 (Catawba 1). The third 10-year interval for Catawba 1 started June 29, 2005, and ends June 29, 2015. The licensee already performed the scheduled third 10-year ISI interval on the referenced welds and components resulting in limited volumetric and visual coverage. As a result, the licensee has proposed that no alternate examinations or testing will be performed during the end of operating cycle 16 to compensate for the limited ultrasonic examination coverage.

2.0 REGULATORY REQUIREMENTS

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.55a(g) specifies that inservice inspection (ISI) of nuclear power plant components shall be performed in accordance with the requirements of the ASME Code, Section XI, except where specific written relief has been granted by the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR Part 50, Section 50.55a(g)(6)(i). Section 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Section 50.55a(g)(5)(iii) states that if the licensee has determined that conformance with certain code requirements is impractical for its facility, the licensee shall notify the NRC and submit, as specified in 10 CFR 50.4, information to support the determinations.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service

examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of 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 of the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable code of record for the third ISI interval for Catawba 1 is the ASME Code, Section XI, 1998 edition thru the 2000 addenda.

3.0 TECHNICAL EVALUATION

The information provided by the licensee in support of this request for relief from ASME Code requirements has been evaluated and the basis for disposition is documented below. For clarity, the request has been evaluated in several parts according to ASME Code Examination Category.

3.1 Request for Relief 07-CN-004, Part A, Examination Category B-J, Item B9.11, Pressure Retaining Welds in Piping

ASME Code Requirement

ASME Code, Section XI, Examination Category B-J, Item B9.11 requires essentially 100-percent surface and volumetric examination, as defined by Figure IWB-2500-8, of the length of selected Class 1 circumferential welds in piping systems. "Essentially 100 percent," as clarified by ASME Code Case N-460, *Alternative Examination Coverage for Class 1 and Class 2 Welds*, is greater than 90-percent coverage of the examination volume, or surface area, as applicable. ASME Code Case N-460 has been approved for use by the NRC in Regulatory Guide (RG) 1.147, Revision 15, "Inservice Inspection Code Case Acceptability."

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from examining 100 percent of the ASME Code-required inspection volume(s) shown in Figure IWB-2500-8 for the piping welds listed in Table 3.1.1 below.

Table 3.1.1 – Examination Category B-J Limited Volumetric Examinations

Component Number	Description	Coverage Obtained
1NC28-11	Valve-to-elbow weld	35.1 percent
1NC31-1	Valve-to-elbow weld	37.5 percent
1NI18-2	Valve-to-pipe weld	62.5 percent
1NI148-10	Valve-to-tee weld	37.5 percent
1NI148-11	Valve-to-tee weld	37.5 percent

Licensee's Basis for Relief Request (as stated)

> Weld joint geometry and material selection caused limitations resulting in the inability to achieve the [ASME Code]-required volumetric coverage. The

> limitations were caused by the tapers [slopes] on the valve side of the welds which prevented scanning from that side.
>
> Ultrasonic examinations of the welds were conducted using personnel qualified in accordance with ASME [Code,] Section XI, Appendix VII. The ultrasonic procedures, personnel and equipment complied with the requirements of ASME [Code,] Section XI, Appendix VIII, 1998 Edition through 2000 Addenda, as administered by the PDI. In addition, dye penetrant [PT] examinations were performed on the welds in accordance with ASME [Code,] Section XI. No recordable or reportable indications were found.

Licensee's Proposed Alternative Examination (as stated)

> Use of radiography (RT) to achieve more coverage has been evaluated. RT is less sensitive to service induced cracking and has not been subjected to the performance demonstration requirements in a manner similar to the ultrasonic method. Therefore, while RT could in most cases provide more coverage, the reduction in sensitivity and lack of performance demonstration mitigates its use. No alternative examinations are planned for the weld[s] during the current inspection interval.

NRC Staff's Evaluation

The ASME Code requires 100-percent volumetric and surface examination of selected ASME Code, Class 1 circumferential piping welds. In addition, the ASME Code requires that the volumetric examination be conducted from both sides of these pressure-retaining circumferential welds. However, the austenitic stainless steel materials and design configurations of the subject welded components limit ultrasonic scanning to a single side. In order to effectively increase the examination coverage, the pipe/tee/elbow-to-valve configurations would require design modifications or replacement. This would place a significant burden on the licensee; thus, 100-percent ASME Code-required volumetric examinations are impractical.

Welds 1NC28-11 and 1NC31-1 are valve-to-elbow circumferential butt welds in 6-inch nominal pipe size (NPS) piping with wall thicknesses of approximately 0.72-inches. Welds 1NI18-2, 1NI148-10, and 1NI148-11 are valve-to-pipe/tee circumferential butt welds in 10-inch NPS piping with wall thicknesses of approximately 1.0 inches. These welds join austenitic stainless steel piping components (tees, elbows and pipes) to valves, where the outside diameter (OD) surface of the valve casting has an extreme taper and/or surface curvature which prevents performing ultrasonic scans from the valve side. In addition, most of the weld crowns are also OD-tapered or have weld build-up that restricts scanning the weld by placing a transducer directly over the crown area. These geometric conditions limit examinations to only the piping component side of the welds.

As shown on the sketches and technical descriptions[1] included in the licensee's submittal, examinations of the subject piping welds have been completed to the extent practical with aggregate volumetric coverage ranging from 35.1 percent to 62.5 percent of the ASME Code-

[1] Sketches and technical descriptions provided by the licensee are not included in this safety evaluation.

required volumes (see Table 3.1.1 above). The ultrasonic examinations included 45- and 60-degree shear waves from the pipe/tee/elbow side of the welds, which account for the aggregate coverage reported. In addition, the licensee performed 60-degree refracted longitudinal wave (L-wave) examinations from the accessible side of these welds. The L-wave examinations covered additional weld/base metal volumes on the valve sides of the welds ranging from 20 to 50 percent of the ASME Code requirement. This additional volume has not been credited in the licensee's reported aggregate coverage because the L-wave technique has not been fully qualified through the industry's PDI program for flaw detection on the far-side of austenitic welds. However, the L-wave method is believed capable of detecting planar inside diameter (ID) surface-breaking flaws on the far-side of wrought stainless steel welds. Recent studies[2,3] recommend the use of both shear and L-waves to obtain the best detection results, with minimum false calls, in austenitic welds. The licensee completed the ASME Code-required surface examinations on the subject welds with no limitations. No recordable indications were observed during the ultrasonic and surface examinations.

The licensee has shown that it is impractical to meet the ASME Code-required 100-percent volumetric examination coverage for the subject piping welds due to the OD surface configurations. Based on the volumetric coverage obtained for the subject welds, and considering the licensee's performance of both ultrasonic shear and L-wave methods to maximize this coverage, it is reasonable to conclude that if significant service-induced degradation were occurring, evidence of it would have been detected by the examinations that were performed.

3.2 Request for Relief 07-CN-004, Part B, Examination Category C-B, Item C2.11, Pressure Retaining Nozzle Welds in Vessels

ASME Code Requirement

ASME Code, Section XI, Examination Category C-B, Item C2.11 requires 100-percent surface examination, as defined in Figure IWC-2500-3, of nozzle-to-shell or nozzle-to-head welds in Class 2 vessels less than .5 inches in nominal thickness. ASME Code Case N-460, as an alternative approved for use by the NRC in RG 1.147, Revision 15, states that a reduction in examination coverage due to part geometry or interference for any Class 1 or 2 weld is acceptable provided that the reduction is less than 10 percent, i.e., greater than 90-percent examination coverage is obtained.

Licensee ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from examining 100 percent of the ASME Code-required inspection surface shown in ASME Code, Section XI, Figure IWC-2500-3 for outlet nozzle-to-shell weld 1SWRF-1-OUTLET on the seal water filter in the Chemical and Volume Control System.

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2 Ammirato, F.V., X. Edelmann, and S.M. Walker, *Examination of Dissimilar Metal Welds in BWR Nozzle-to-Safe End Joints*, 8th International Conference on NDE in the Nuclear Industry, ASM International, 1987.

3 Lemaitre, P., T.D. Koble, and S. R. Doctor, *PISC III Capability Study on Wrought-to-Wrought Austenitic Steel Welds: Evaluation at the Level of Procedures and Techniques*, Effectiveness of Nondestructive Examination Systems and Performance Demonstration, PVP-Volume 317, NDE-Volume 14, ASME, 1995.

Licensee's Basis for Relief Request (as stated)

> The vessel, nozzle and weld materials are stainless steel. The nozzle side of the weld has a diameter of 2.875" [inches]. During the liquid penetrant examination of this weld, 74.60% [percent] coverage of the required surface examination area was obtained. The areas that were not examined were inaccessible due to the proximity of the seal water filter housing legs to the nozzle-to-shell weld. Two of the four housing legs are welded to the vessel in a manner that covers a portion of the required base metal on the vessel side of the weld at both 90 and 270 degrees. The liquid penetrant exam performed covered 100% [percent] of the weld and the required base metal on the nozzle side of the weld. The required area of base metal on the vessel side of the weld was examined from 350 to 100 degrees and 170 to 190 degrees; however, the base metal from 10 to 170 degrees and 190 to 350 degrees was inaccessible due to the legs.

Licensee's Proposed Alternative Examination (as stated)

> Use of the ultrasonic inspection method was evaluated for inspecting the limited area. Due to the stainless steel material and configuration of the component, and the close proximity of the legs to the weld, the area was not accessible for ultrasonic examination. No alternative examinations are planned for the weld during the current inspection interval.

NRC Staff's Evaluation

The ASME Code requires 100-percent surface examination of selected nozzle-to-shell welds on Class 2 vessels less than 0.5-inches in nominal thickness. However, integrally welded support legs on the seal water filter housing are located in close proximity to the subject weld, limiting access for full surface examination. For the licensee to achieve 100-percent surface coverage, the vessel and integral support legs would have to be redesigned and modified. This would place a burden on the licensee, thus the ASME Code-required 100-percent surface examination is impractical.

The seal water filter housing is a vertically oriented vessel that is supported by structural steel legs integrally welded to the outside surface of the shell. These support legs have been fit on either side of the outlet nozzle and limit access for approximately 4 inches of the circumference in two areas centered around 90 and 270 degrees on the nozzle-to-shell weld. The support legs prevent the licensee from performing a surface examination on the entire weld and adjacent base material of the shell as required by the ASME Code. However, as shown on the sketches and technical descriptions[4] included in the licensee's submittal, examination of the seal water return outlet nozzle-to-shell weld has been completed to the extent practical with the licensee obtaining coverage of approximately 75 percent of the ASME Code-required surface. No reportable indications were detected during the limited examination. The licensee has shown that it is impractical to meet the ASME Code-required 100-percent surface examination coverage for the seal water return outlet nozzle-to-vessel weld due to the proximity of integrally

[4] Sketches and technical descriptions provided by the licensee are not included in this safety evaluation.

welded housing legs. However, based on the surface examination coverage obtained for the subject weld, it is reasonable to conclude that if significant service-induced degradation were occurring, evidence of it would have been detected by the examination that was performed.

3.3 Request for Relief 07-CN-004, Part C, Examination Category C-F-1, Items C5.11 and C5.21, Pressure Retaining Welds in Austenitic Stainless Steel or High Alloy Piping

ASME Code Requirement

ASME Code, Section XI, Examination Category C-F-1, Items C5.11 and C5.21 require volumetric and surface examination, as defined by Figure IWC-2500-7, of Class 2 circumferential welds in austenitic or high alloy piping. ASME Code Case N-460, *Alternative Examination Coverage for Class 1 and Class 2 Welds*, as an alternative approved for use by the NRC in RG 1.147, Revision 15, states that a reduction in examination coverage due to part geometry or interference for any Class 1 or 2 weld is acceptable provided that the reduction is less than 10 percent, i.e., greater than 90-percent examination coverage is obtained.

Licensee's Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from examining 100 percent of the ASME Code-required inspection volume shown in ASME Code, Section XI, Figure IWC-2500-7 for the piping welds shown in Table 3.3.2 below:

Table 3.3.2 – Examination Category C-F-1 Limited Volumetric Examinations

Component Number	Plant Piping System	Description	Coverage Obtained
1ND3-1	Residual Heat Removal	Valve-to-pipe weld	37.5 percent
1NI1-12	Safety Injection	Valve-to-pipe weld	37.5 percent
1NV-309-INLET	Chemical and Volume Control	Valve-to-reducer weld	37.5 percent
1NV-309-OUTLET	Chemical and Volume Control	Valve-to-reducer weld	37.5 percent

Licensee's Basis for Relief Request (as stated)

> Weld joint geometry and material selection caused limitations resulting in the inability to achieve the [ASME Code]-required volumetric coverage. The limitations were caused by the tapers [slopes] on the valve side of the welds which prevented scanning from that side.
>
> Ultrasonic examinations of the welds were conducted using personnel qualified in accordance with ASME [Code,] Section XI, Appendix VII. The ultrasonic procedures, personnel and equipment used complied with the requirements of ASME [Code,] Section XI, Appendix VIII, 1998 Edition through 2000 Addenda, as administered by the Performance Demonstration Initiative (PDI). In addition, [PT] examinations were performed on the welds in accordance with ASME [Code,] Section XI. No recordable or reportable indications were found.

Licensee's Proposed Alternative Examination (as stated)

> Use of [RT] to achieve more coverage has been evaluated and discarded because RT is less sensitive to service induced cracking and has not been subjected to the performance demonstration requirements in a manner similar to the ultrasonic method. While RT could in most cases provide more coverage the loss of sensitivity and lack of performance demonstration mitigates against its use. No alternative examinations are planned for the weld during the current inspection interval.

NRC Staff's Evaluation:

The ASME Code requires 100-percent volumetric and surface examination of selected ASME Code, Class 2 circumferential piping welds in high alloy piping systems. In addition, the ASME Code requires that the volumetric examination be conducted from both sides of these pressure retaining circumferential welds. However, the austenitic stainless steel materials and design configurations of the subject welded components limit ultrasonic scanning to a single side. In order to effectively increase the examination coverage, the pipe/reducer-to-valve configurations would require design modifications or replacement. This would place a significant burden on the licensee; thus, 100-percent ASME Code-required volumetric examinations are impractical.

Weld 1ND3-1 is a valve-to-pipe circumferential butt weld in 18-inch NPS piping with a wall thickness of approximately 0.56 inches. Weld 1NI1-12 is a valve-to-pipe circumferential butt weld in 6-inch NPS piping with a wall thickness of approximately 0.72 inches. Welds 1NV-309-INLET and 1NV-309-OUTLET, are valve-to-concentric reducer circumferential butt welds in 2 inch NPS piping with wall thicknesses of approximately 0.34-inch. These welds join austenitic stainless steel piping components (pipe and reducers) to valves, where the OD surface of the valve casting has an extreme taper and/or surface curvature which prevents performing ultrasonic scans from the valve side. In addition, the weld crowns may also be OD-tapered or have weld build-up that restricts scanning the weld by placing a transducer directly over the crown area. These geometric conditions limit examinations to only the piping component side of the welds.

As shown on the sketches and technical descriptions[5] included in the licensee's submittal, examinations of the subject piping welds have been completed to the extent practical with aggregate volumetric coverage of approximately 37.5 percent of the ASME Code-required volumes for each of these welds. The ultrasonic examinations on Welds 1ND3-1 and 1NI1-12 included 45- and 60-degree shear waves from the pipe side of the welds, which account for the aggregate coverage reported. Because of the relatively thin wall piping on Welds 1NV-309-INLET and 1NV-309-OUTLET, 45- and 70-degree shear waves from the pipe side were performed.

In addition, the licensee performed 60- or 70-degree, as applicable, refracted L-wave examinations from the accessible side of these welds. The L-wave examinations covered additional weld/base metal volumes on the valve sides of the welds ranging from 3.5 to 50 percent of the ASME Code requirement. This additional volume has not been credited in the licensee's reported aggregate coverage because the L-wave technique has not been fully

5 Sketches and technical descriptions provided by the licensee are not included in this safety evaluation.

qualified through the industry's PDI for flaw detection on the far-side of austenitic welds. However, the L-wave method is believed capable of detecting planar ID surface-breaking flaws on the far-side of wrought stainless steel welds. Recent studies[6, 7] recommend the use of both shear and L-waves to obtain the best detection results, with minimum false calls, in austenitic welds. The licensee completed the ASME Code-required surface examinations on the subject welds with no limitations. No recordable indications were observed during the ultrasonic and surface examinations.

The licensee has shown that it is impractical to meet the ASME Code-required 100-percent volumetric examination coverage for the subject piping welds due to the OD surface configurations. Based on the volumetric coverage obtained for the subject welds, and considering the licensee's performance of both ultrasonic shear and L-wave methods to maximize this coverage, it is reasonable to conclude that if significant service-induced degradation were occurring, evidence of it would have been detected by the examinations that were performed.

4.0 NRC STAFF'S CONCLUSIONS

The staff has reviewed the licensee's submittal and concludes that ASME Code examination coverage requirements are impractical for the subject welds listed in Request for Relief No. 07-CN-004, Parts A, B and C. Based on the coverage obtained, if significant service-induced degradation were occurring, there is reasonable assurance that evidence of it would have been detected by the examinations that were performed. The staff further concludes that the licensee's proposed alternative to examine the subject components to the extent practical provided reasonable assurance of structural integrity of the components contained in Request for Relief No. 07-CN-004, Parts A, B and C. Therefore, for the items in this request, relief is granted, pursuant to 10 CFR 50.55a(g)(6)(i), for the third 10-year ISI interval at Catawba Nuclear Station, Unit 1.

The staff has determined that granting relief for Request for Relief No. 07-CN-004, Parts A, B and C pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property, or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in the subject requests for relief remain applicable, including third-party review by the authorized Nuclear Inservice Inspector.

Principal Contributors: T. McLellan
D. Nuajock

Date: August 8, 2008

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6 Ammirato, F.V., X. Edelmann, and S.M. Walker, *Examination of Dissimilar Metal Welds in BWR Nozzle-to-Safe End Joints*, 8th International Conference on NDE in the Nuclear Industry, ASM International, 1987.

7 Lemaitre, P., T.D. Koble, and S.R. Doctor, *PISC III Capability Study on Wrought-toWrought Austenitic Steel Welds: Evaluation at the Level of Procedures and Techniques*, Effectiveness of Nondestructive Examination Systems and Performance Demonstration, PVP-Volume 317, NDE-Volume 14, ASME, 1995.