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U. S. Nuclear Regulatory Commission
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SUBJECT: Duke Power Company LLC d/b/a Duke Energy Carolinas, LLC (Duke)
McGuire Nuclear Station, Units 1 & 2
Docket Numbers 50-369 and 50-370
Catawba Nuclear Station, Units 1 & 2
Docket Numbers 50-413 and 50-414
Relief Request 06-GO-001Request for Additional Information

On July 27, 2006 Duke submitted Relief Request 06-GO-001 pursuant to 10 CFR 50.55a(a)(3)(i), requesting NRC approval to use alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI inservice inspection (ISI) requirements for the McGuire and Catawba Nuclear Stations, Units 1 & 2. This proposed alternative approach is to support application of full structural weld overlays on various pressurizer nozzle-to-safe end welds and will provide an acceptable level of quality and safety.

On August 30, 2006, the NRC Staff electronically requested additional information regarding several issues contained within the relief request. The Duke response is attached.

If you have any questions or require additional information, please contact Mary Shipley at (704) 382-5880.

Sincerely,

M R Robinson/for

James R. Morris

Enclosure

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Saluda River Electric Cooperative, Inc.
Piedmont Municipal Power Agency
North Carolina Electric Membership Corporation
MNS MasterFile MC-801.01 (MG01DM)
CNS MasterFile CN-801.01 (CN04DM)
ONS MasterFile ON-801.01 (ON03DM)
ELL

1. Provide the interval over which relief is requested to perform the proposed structural weld overlays.

   Response:
   The full structural weld overlays will be installed during the third interval for each of the units included in the relief request.

2. Provide the current inservice inspection interval for Catawba and McGuire Units 1 and 2. Include interval start and end dates.

   Response:

Catawba Unit 1 third interval:	Begin 6/29/2005	End 6/29/2015
Catawba Unit 2 third interval:	Begin 10/15/2005*	End 8/19/2016
McGuire Unit 1 third interval:	Begin 12/1/2001	End 12/01/2011
McGuire Unit 2 third interval:	Begin 3/1/2004	End 2/28/2014

   * Interval started early to get both units on same code.

3. Section 6.0 "Weld Overlay Design and Verification" of the submittal states that the following will be performed after the completion of the preemptive weld overlay (PWOL):

   (4) Shrinkage will be measured during the overlay application. Shrinkage stresses at other locations in the piping systems arising from the weld overlays will be demonstrated not to have an adverse effect on the systems. Clearances of affected support and restraints will be checked after the overlay repair, and will be reset within the design ranges as required.

   (5) The total added weight on the piping systems due to the overlays will be evaluated for potential impact on piping system stresses and dynamic characteristics.

   (6) The as-built dimensions of the weld overlays will be measured and evaluated to demonstrate that they equal or exceed the minimum design dimensions of the overlays.

   It is the staffs expectation that the above activities be performed prior to start-up. Verify that the task outlined in 6.0 (4), 6.0 (5) and 6.0 (6) of the July 27, 2006 submittal will be completed prior to start-up.

   Response:
   The analyses and evaluations described in items 4 through 6 will be completed prior to entry into Mode 4.

4. Section 6.0 of the July 27, 2006 submittal indicates that the overlay design will not take credit for the underlying primary water stress corrosion cracking (PWSCC) susceptible material. 6.0 (2) states that "potential crack growth will be evaluated due to PWSCC as well as due to fatigue crack growth in the original DMW [dissimilar metal weld]." In order to perform fracture mechanics analysis, what crack size is assumed to already exist in the original weld ?. If the assumed crack size is not 360 degrees and 100% through-wall, provide the assumed flaw size and a bases for the assumed flaw size given that welds will not receive a volumetric examination prior to welding.
   Response:

The design basis flaw for the purpose of structural sizing of the overlay is assumed to be 360 degrees and 100% through the original wall thickness of the DMW. For the crack growth analysis the initial flaw size is assumed to be 360 degrees and 75% through the original wall thickness. The 75% through-wall assumption is selected based upon the PDI-qualified inspection of the overlay at the conclusion of the weld overlay process, which includes the outer 25% of the original weld. If flaws are detected in the post-overlay inspection, they will be evaluated in accordance with the requirements of Code Case N-504-2 and Appendix Q.

5. Given that the proposed weld overlay encompasses the stainless steel safe end to stainless steel RCS piping, provide the specification and grade of filler metal used to join the safe end to the RCS piping for each safe end to be weld overlayed.

<u>Response:</u>
All the stainless steel safe end to RCS piping welds were made with filler material conforming to AWS class E308 or ER308 for chemistry as required by ASME Section III, subsection NB-2000.

6. Table 3 of the July 27, 2006 submittal indicates that the NDE requirement under 4.0(b) of N-638-1, ultrasonic examination of the 1.5T band on either side of the overlay, will not be met. If this requirement cannot be met, please discuss the achievable amount of area that can be successfully examined for each preemptive weld overlay weld design configuration you wish to apply. Secondly, clarify whether the ultrasonic test examination will be performed to the maximum extent achievable. Although the July 27, 2006 submittal references Code Case N-638-3 in support of the relief request, the staff notes that Code Case N-638-3 has not been endorsed by the NRC.

<u>Response:</u>
(a) Code Case N-638-1 addresses the use of the temper bead welding technique including those welds made in deep cavities in ferritic material. In the case of weld overlays to be applied at MNS/CNS, this technique will be used to apply a non-ferritic overlay to the P3 ferritic nozzle base material adjacent to the dissimilar metal weld (DMW). The PDI qualified ultrasonic examination procedure is designed and qualified to examine the entire volume of the overlay weld as well as the region of the P3 material containing the weld heat affected zone (HAZ) and a volume of unaffected base material beyond the HAZ. In addition to verifying the soundness of the weld, a purpose of these examinations is to assure that delayed cracking that may be caused by hydrogen introduced during the temper bead welding process is not present. In the unlikely event that this type of cracking does occur, it would be initiated on the surface on which the welding is actually performed or in the HAZ immediately adjacent to the weld. The most appropriate technique to detect surface cracking is the surface examination technique that Duke will perform on the weld overlay and the adjacent base material in a band at least 1.5 times the thickness of the base material on either side of the overlay. The maximum achievable inspection volume is 100% of the volume susceptible to weld induced flaws.

(b) Duke does not propose to perform ultrasonic examination to the maximum achievable extent in the 1.5T band on either side of the overlay. While it would be possible to extend the examination volume to a larger extent on either side of the weld overlay, it would not be possible with current technology to ultrasonically inspect 100% of the volume within 1.5 times the thickness of the base material because of geometric considerations. Inspection of an increased volume would result in increased dose to inspection personnel without a compensating increase in safety or quality because there is no plausible mechanism for formation of new flaws or propagation of existing flaws in the region. The overlay volume is small relative to the volume of the underlying pipe and does not present the same concerns as those related to welds in deep cavities contemplated by the requirements of Code Case N-638-1. Therefore, the examinations tailored for overlay inspection and required by Code Case N-504-2 and Appendix Q as modified in the request for relief provide full assurance that the weld and adjoining base material are fully capable of performing their intended function. Approval by ASME Code in 2005 and 2006 of Code Cases N-638-2 and N-638-3 respectively recognizes that inspection of the larger volume is not necessary to assure quality and safety.

(c) The NRC has previously granted relief on this specific issue for temper bead welding for use at other plants for the reasons mentioned above. Specifically, San Onofre Nuclear Generating Station Unit 2 in the Spring of 2006, Millstone Power Station, Unit No. 3 in January 2006, and Three Mile Island Unit 1 in Fall 2003 have received approval to use inspection methods essentially identical to those proposed by Duke.

7. The submittal indicates that the weld surface areas over ferritic material for the subject weld overlays are expected to be approximately 120 square inches for the surge line nozzles. Provide a discussion on how the information in the white paper referenced in your submittal directly applies to the configuration of the surge line nozzles and supports your request to exceed the current 100 sq in limitation in Code Case N-638-1. Also discuss operational experience at other nuclear power plants with weld overlays that exceed 100 sq in. Although the submittal references requirements of Code Case N-638-3 as justification for increasing the allowable overlay surface area, the staff notes that Code Case N-638-3 has not been endorsed buy the NRC.

Response:
The white paper referenced in our submittal was part of an ASME Code action that sought (and succeeded) in relaxing an arbitrary limitation that was included in N-638 to restrict the use of the ambient temperature bead welding to a surface area of less than 100 in^2. Later revisions to this Code Case (N-638-2 and N-638-3), approved by ASME Code in 2005 and 2006 respectively, have extended the 100 in^2 limit to 500 in^2.

The white paper addressed three potential technical concerns that the 100 in^2 limitation may have been intended to prevent: residual stresses, tempering of the weld HAZ, and the possible (but unlikely) development of delayed hydrogen cracking in the underlying ferritic base material. The applicability of the white paper to the MNS/CNS surge nozzle weld overlay design is addressed individually for each of these potential concerns below:

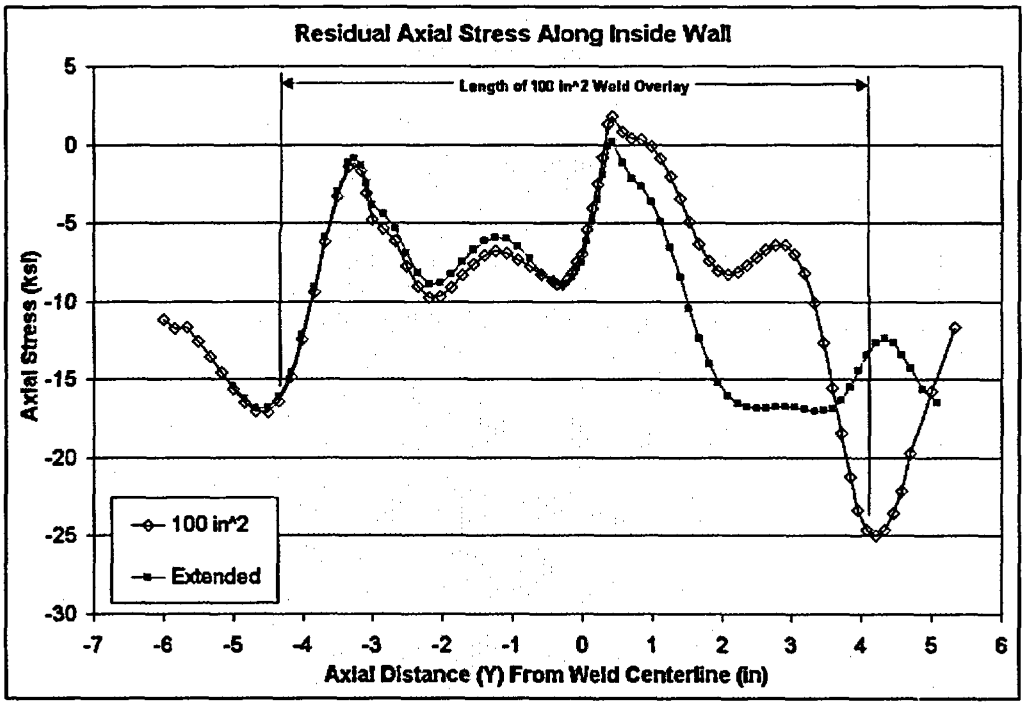
(a) Residual Stresses – Using as an example a BWR Feedwater Nozzle, the white paper cites EPRI sponsored analyses [1] of an overlay that just equaled 100 in^2 coverage over the ferritic steel base metal. Two axisymmetric finite element models were created, one with the 100 in^2 weld overlay and the other with the weld overlay extended on the nozzle side until it blended into the nozzle taper surface (approximately 126 in^2). Figure 1 shows the post overlay residual stress on the nozzle inside surface for both models. It is seen that the extended overlay configuration did not significantly alter the residual stress results, and if anything, made the axial stresses even more compressive.

The Feedwater nozzle configuration modeled in [1] was roughly similar to the MNS and CNS surge nozzles; however it is not necessary to rely on this similarity, since nozzle specific residual stress analyses are being conducted as part of the Duke PWOL project. The resulting post-overlay inside surface residual stress distributions for the MNS/CNS surge nozzles are shown in Figure 2. It is seen from this figure that the MNS/CNS surge nozzle weld overlay design, with its ~120 in^2 coverage over the ferritic steel base metal, creates favorable compressive residual stresses on the inside surface of the nozzle.

(b) HAZ Tempering – The white paper cites past programs which have demonstrated that temper bead welding using automatic GTAW provides adequate tempering of the HAZ in P-1 and P-3 materials and does not degrade strength or fracture toughness for temper bead weld overlays. Reference [2] presents results of a bimetallic weld overlay mockup of a 12 inch diameter, SA-508 Class 2 low alloy steel nozzle. The overlay applied to this nozzle covered ~119 in^2 of the low alloy steel nozzle (approximately the same as the MNS/CNS surge nozzle overlay). Microstructure and microhardness measurements were performed on the HAZ of this overlay, as well as mechanical property tests (Charpy and Tensile) of a groove weld in the same nozzle with similar coverage area. The mechanical property results verified that the weld overlay repair did not degrade the strength or toughness of the low alloy steel HAZ. Microstructure and microhardness results demonstrated adequate tempering of the material, such that Hydrogen embrittlement would not be expected. This demonstration was conducted on a weld overlay geometry with essentially identical low alloy steel (LAS) coverage as the MNS/CNS surge nozzle overlay.

(c) Delayed Hydrogen Cracking – Inspections of the above described mockup, as well as extensive inspections of temper bead weld overlays in mockups and in the field, have been performed, of overlays with LAS coverages ranging from less than 10 in^2 up to and including 325 in^2. These have shown that hydrogen induced cracking has not been a problem with repairs produced by the automatic GTAW temper bead process. The process is by its nature a low hydrogen process, and diffusion of hydrogen is very rapid for low alloy steels. Nonetheless, the post weld soaks specified in the Code are intended as post hydrogen bake outs permitting NDE after the repair has returned to ambient temperature. N-638, since it does not impose the post weld bake, requires a 48-hour hold time prior to NDE, to verify that the unlikely event of hydrogen induced cold cracking has not occurred. The Duke weld overlay procedure will conform to the 48-hour hold time requirement prior to performing NDE. Furthermore, the metallurgical aspects discussed above are independent of the surface area of the repair but related to parameters of the qualified welding procedure.

Finally, it is important to note that the above theoretical arguments have been proven in practice by extensive field experience with temper bead weld overlays, with LAS coverage ranging from less than 10 in^2 up to and including 325 in^2. 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 LAS coverage in the 100 in^2 range have been in service for 5 to 15 years. Several overlays have been applied with LAS coverage significantly greater than the 100 in^2. 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. One such specific incidence [Constellation Energy Relief Request (ML060240110) for Calvert Cliffs] was referenced in Duke's original submittal.



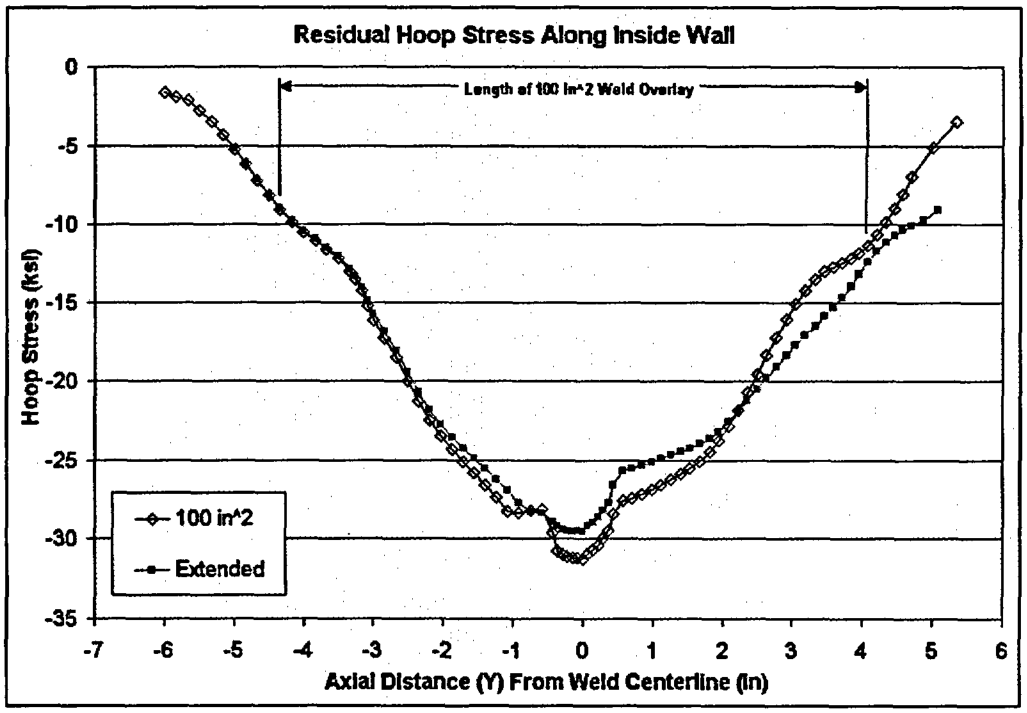


Figure 1 Residual Stress Distribution from White Paper (see Text)

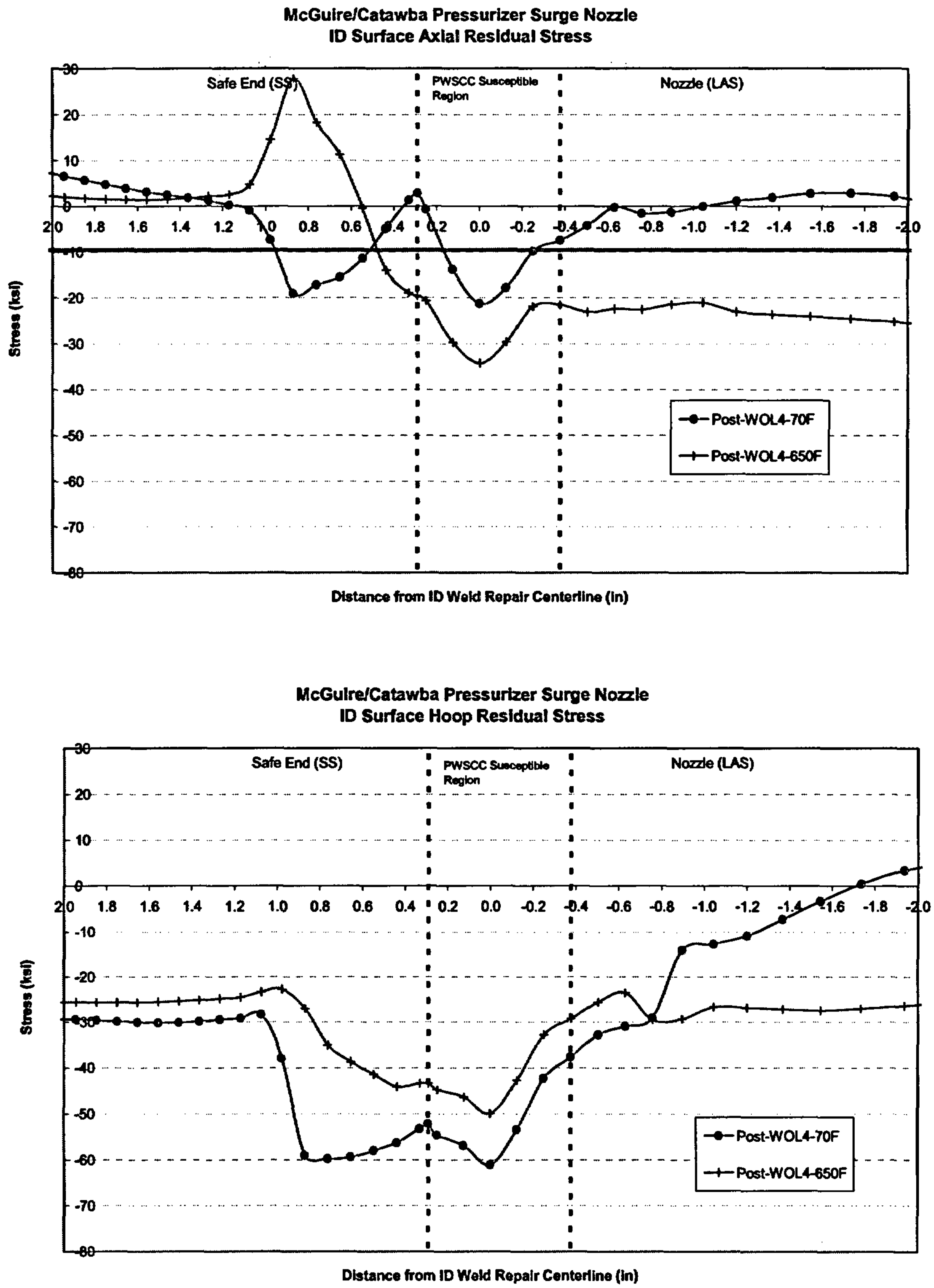


Figure 2 Calculated Residual Stress Distribution for McGuire and Catawba (see Text)

Table 1 – Dissimilar Metal Weld Overlay Experience

Date	Plant	Component	Nozzle Diameter (in)	Approx. LAS Coverage (in^2)
April 2006	Davis Besse	Hot leg drain nozzle	4	16
February 2006	SONGS Unit 2	PZR spray nozzle	8	50
		safety/relief nozzles	6	28
November 2005	Kuosheng Unit 2	Recirculation outlet nozzle	22	250
April 2004	Susquehanna Unit 1	Recirc. inlet nozzle	12	100
		Recirc. outlet nozzle	28	325
November 2003	TMI Unit 1	Surge line nozzle	11.5	75
October 2003	Pilgrim	Core spray nozzle	10	50
		CRD return nozzle	5	20
October 2002	Peach Bottom Units 2 & 3	Core spray nozzle	10	50
		Recirc. outlet nozzle	28	325
		CRD return nozzle	5	20
October 2002	Oyster Creek	Recirc. outlet nozzle	26	285
December 1999	Duane Arnold	Recirc. inlet nozzle	12	100
June 1999	Perry	Feedwater nozzle	12	100
June 1998	Nine Mile Point Unit 2	Feedwater nozzle	12	100
March 1996	Brunswick Units 1 & 2	Feedwater nozzle	12	100
February 1996	Hatch Unit 1	Recirc. inlet nozzle	12	100
January 1991	River Bend	Feedwater nozzle	12	100
March 1986	Vermont Yankee	Core spray nozzle	10	50

References (Question 7):

1. "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.
2. "Inconel Weld-Overlay Repair for Low-Alloy Steel Nozzle to Safe-End Joint", EPRI NP-7085-D, January 1991.

8. Is Code Case N–416-2 currently implemented within the current ISI programs at Catawba and McGuire Units 1 and 2.

Response:
Code Case N-416-2 is not listed within the current ISI Program Plan. The requirements of Code Case N-416-2 were incorporated into Section XI and are implemented in ASME Boiler and Pressure Vessel Code Section XI 1998 Edition through 2000 Addenda applicable to the third inspection interval for each of the units for which relief is requested.