VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

May 20, 2002

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

Serial No.	02-281
NL&OS/ETS	R0
Docket No.	50-339
License No.	NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 2
ALTERNATIVE REPAIR TECHNIQUES
REACTOR VESSEL HEAD REPAIR CMP-16 AND CMP-17

There have been several recent instances of cracking in reactor vessel head penetrations constructed of Alloy 600 in pressurized water reactor nuclear power plants. In response to the industry initiative on the reactor vessel penetration cracking concern, Virginia Electric and Power Company (Dominion) is planning to inspect the North Anna Unit 2 reactor vessel head and penetrations during an upcoming fall outage. In the event that repairs are required, we request the use of alternative repair techniques in place of the current 1995 ASME Code repair requirements.

Although an alternative to Code requirements, use of the provisions of these relief requests, will produce sound, permanent repair welds and an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), we request relief from the specific ASME Code requirements identified in the attached relief requests for North Anna Unit 2. The relief requests (CMP-016 and CMP-017) for the alternate repair techniques and the bases for these relief requests are provided in Attachments 1 and 2.

In a letter dated October 15, 2001 (Serial No. 01-638), as supplemented in letters dated November 9, 16, and 29, 2001 (Serial Nos. 01-638A, 638B, 638C) Dominion requested approval of the ambient temperature temperbead repair technique (NDE-049) and the embedded flaw repair technique (NDE-048) for North Anna Unit 2 in support of the reactor vessel head penetration inspection and repair activities conducted during the Fall 2001 outage. The supplemental letters provided additional clarification of the inspection, examination, and welding requirements for the proposed alternative weld repair techniques. Since the relief requests, CMP-016 and CMP-017, have only been

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modified to address the new ASME Code Edition (1995), the previously submitted additional information remains applicable to the implementation of the proposed alternative weld repair technique and is therefore, referenced in support of these relief requests.

If you have any questions or require additional information, please contact Mr. Thomas Shaub at (804) 273-2763.

Very truly yours,

Leslie N. Hartz
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Attachment 1

Relief Request CMP-16
Weld Repair of Reactor Vessel Head Penetrations

North Anna Unit 2
Virginia Electric and Power Company
(Dominion)

REQUEST TO USE EMBEDDED FLAW REPAIR TECHNIQUE
NORTH ANNA POWER STATION UNIT 2 RELIEF REQUEST CMP-16

I. Identification of Components

Drawings: 12050-WMKS-RC-R-1.2 Class 1

Control rod drive mechanism (CRDM) penetrations (65) and a head vent penetration (1) on the upper reactor vessel head, which are ASME Class 1 components.

II. Current Code Requirements

The Construction Code of record for the North Anna Unit 2 Reactor vessel and head is the 1968 Edition of ASME Section III with Addenda through the winter of 1968. North Anna Unit 2 is currently in its third inspection interval using the 1995 Edition/1996 Addenda of ASME Section XI. ASME Section XI, paragraph IWA-4221, "Construction Code and Owner's Requirements," specifies the following:

(a) "An item to be used for repair/replacement activities shall meet the Owner's Requirements and the applicable Construction Code to which the original item was constructed, except as provided in IWA-4221 (b) and (c).

(b) The item may meet all or portions of the requirements of different Editions and Addenda of the Construction Code, or Section III when the Construction Code was not Section III, provided the requirements of IWA-4222 through IWA-4226, as applicable, are met. Construction Code Cases may also be used. A Report of Reconciliation, if required, shall be prepared. All or portions of later different Construction Codes may be used ..."

The repairs will be completed in accordance with the 1989 Edition of ASME III and the alternative requirements proposed below.

III. Code Requirements for Which Alternatives Are Requested

Per paragraph IWA-4221, repairs, if required, would be performed in accordance with Section III. Prior to welding, the repair excavation would require examination per paragraph NB-4453 with the acceptance criteria of NB-5340 and NB-5350. In neither case would it be permissible to weld over, or embed, an existing flaw.

Specifically, alternatives are being proposed for the following parts of ASME Section III, NB-4453, "Requirements for Making Repairs of Welds":

NB-4453.1 addresses defect removal and requires magnetic particle or liquid penetrant examinations of the repair excavation with acceptance criteria per NB-5340 or NB-5350. In the proposed repairs, defects will not be removed. Instead, it is proposed that the defects be embedded with a weld overlay which will prevent further growth of the defects by isolating them from the reactor coolant which might cause them to propagate by primary water stress corrosion cracking (PWSCC). Structural integrity of the affected vessel head penetration J-groove weld will be maintained by the remaining unflawed portion of the weld.

NB-4453.2 discusses requirements for welding material, procedures, and welders.

The requirements of this part will be satisfied by the proposed embedded flaw repair process.

NB-4453.3 requires that the repaired areas be uniformly blended into the surrounding surface.

The proposed repairs will satisfy this requirement.

NB-4453.4 stipulates that the repairs be examined in accordance with requirements for the original weld.

In the proposed cases where excavation of the original weld is performed, the repairs will be subject to progressive liquid penetrant examination per the requirements of NB-5245. If no excavation is performed prior to repair welding, the weld overlay will be examined by liquid penetrant on the final surface. In both scenarios acceptance criteria will be per NB-5350.

NB-4453.5 requires the repairs be post weld heat treated per NB-4620.

In the proposed cases, for repairs in the excavations that would require post weld heat treatment (PWHT) per NB-4620, a temperbead welding procedure will be used. Repairs where the remaining thickness of the original weld buttering and/or the existing cladding maintain at least 1/8 inch between the overlay weld and the ferritic base material will not require PWHT per NB-4622.11.

Article IWB-3600, "Analytical Evaluation of Flaws," is not applicable to the proposed embedded flaw repairs because it contains no acceptance criteria for the non-ferritic components and material type in question. As a consequence, we have proposed and the NRC has previously accepted criteria for Alloy 600 inside diameter (ID) penetration tube flaws discussed in WCAP-13565, Rev. 1 for North Anna Unit 1 in 1996.

Paragraphs IWB-3132 and IWB-3142 are not applicable to the proposed embedded flaw repairs because these paragraphs discuss non-relevant requirements related to Code imposed examinations, as is clear from their location in subsubarticle IWB-3130, "Inservice Volumetric and Surface Examinations." The only applicable inservice inspection requirements are stated in Table IWB-2500-1, as stated in the body of the relief request. Table IWB-2500-1 mandates a VT-2 visual inspection from above the reactor vessel head insulation for 100% of the nozzles, as part of a system leakage test with IWB-3522 as the acceptance standard. The examinations that are being performed, which may occasion the need to perform embedded flaw repairs, are therefore in excess of the Code mandated inspection for the reactor head penetrations and attachment welds.

There is no ISI requirement for successive inspections for the penetration tubes or repairs to them, per IWB-2420. This is a consequence of the inapplicability of paragraphs IWB-3132.3 and IWB-3142.4, which specifically discuss flaw evaluations performed utilizing the acceptance criteria of IWB-3600 (which do not apply here).

IV. Basis for Relief

A request to use the embedded flaw technique to repair cracks on the inside diameter (ID) of control rod drive mechanism (CRDM) penetration tubes was previously submitted and approved by the NRC (References 1 through 4 and 8 through 11). This current request expands the scope of the previous submittal to include repair of cracks on the J-groove attachment welds of these penetrations and to outside diameter (OD) cracks on a penetration below the J groove attachment weld.

The 1995 Edition of Section XI with 1996 Addenda, subparagraph IWA-4611.1, permits the use of Section XI flaw evaluation criteria which would not require the complete removal of a flaw unless repairs were being undertaken per the temperbead welding procedures of paragraph IWA-4620, or paragraphs IWA-4630 and IWA-4640 (if the flaw penetrates the base metal). The flaw evaluation criteria of Section XI (refer to Table IWB-3514-2) establishes acceptance criteria for surface connected and embedded flaws.

North Anna Unit 2 has performed qualified visual inspections under the insulation on the reactor vessel head during a mid-cycle outage in the fall of 2001 in response to NRC Bulletin 2001-01. The identification of potentially leaking penetrations resulted in inspections under the vessel head. These inspections, which included eddy current and ultrasonic examination of the CRDM penetration inside diameters (IDs) and liquid penetrant examination of the penetration outside diameters (ODs) and J-groove weld, discovered flaws in the butter region of three penetrations which required repair because they exceeded Section XI acceptance criteria. The flaws were apparently associated with hot cracking existing in the welds since original construction. This conclusion was based on the findings of a metallurgical analysis of a J groove weld boat sample that included several representative weld flaws. The report indicated all cracks were confined to the buttering region (Reference 14). This relief request will permit the flaws on J-groove attachment welds to be repaired with techniques documented in WCAP-13998, Revision 1, "RV Closure Head Penetration Tube ID Weld Overlay Repair," (Reference 1) using an embedded flaw repair technique. Evaluation of the structural integrity of the welds has shown that in the worst case only 15% of the J-groove weld is required to be intact in order to satisfy Code strength requirements, documented in WCAP-14552, Revision 2, (Reference 12).

The embedded flaw repair technique is considered a permanent repair for the following reasons: first, as long as a Primary Water Stress Corrosion Cracking (PWSCC) flaw remains isolated from the primary water (PW) environment, it cannot propagate. Since an Alloy 52/152 weldment (equivalent to Alloy 690) is considered highly resistant to PWSCC, a new PWSCC crack should not initiate and grow through the Alloy 52/152 overlay to reconnect the PW environment with the embedded flaw. The high PWSCC resistance of the Alloy 690 material has been repeatedly demonstrated by laboratory testing in simulated pressurized water reactor (PWR) environments, and in approximately 10 years of operational service in steam generator tubes, where likewise no PWSCC has been found. Industry/laboratory experience with Alloy 690 has been summarized in EPRI Report TR-109136, "Crack Growth and Microstructural Characterization of Alloy 600 PWR Vessel Head Penetration Materials," (Ref. 13). Second, the residual stresses produced by the embedded flaw technique have been measured and found to be relatively low (Reference 1). Low residual stresses imply that no new cracks should initiate and grow in the area adjacent to the repair weld. This conclusion was verified in January of 2002 when DC Cook Unit 2 performed their NRC Bulletin 2001-01 inspections. Using liquid penetrant testing, they detected no discernible cracks had initiated at the base of an embedded flaw repair made on an ID penetration tube surface in April 1996 (Reference 15). Third, there are no other known mechanisms for significant crack propagation in this region because the cyclic fatigue loading is considered negligible. The cumulative Usage Factor (CUF) in the upper head region was calculated in an aging management review report (Ref. 7) as 0.068.

The thermal expansion properties of Alloy 52/152 weld metal are not specified in the ASME Code, as is the case for other weld metals. In this case, the properties of the equivalent base metal (Alloy 690) should be used. Alloy 690's thermal expansion coefficient at 600°F is 8.2 E-6 in/in/degree F as found in ASME Section II Part D. The Alloy 600 base metal has a somewhat smaller coefficient of thermal expansion of 7.8 E-6 in/in/degree F.

The effect of this difference in thermal expansion is that the 52/152 (Alloy 690) weld overlay will contract more than the Alloy 600 base metal when it cools, thus producing a compressive stress on the Alloy 600 tube or the underlying attachment weld, where the crack may be located. This beneficial effect has already been accounted for in the residual stress measurements reported in the technical basis for the embedded flaw repair.

The small additional residual stress produced by the embedded flaw 52/152 weld overlay will act constantly, and therefore, will have no impact on the fatigue effects in the CRDM region. Since the stress would be additive to the maximum as well as the minimum stress, the stress range would not change, and the already negligible usage factor, noted above, for the region would not change. Therefore, the embedded flaw repair technique is considered to be an alternative to Code requirements that provides an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

V. **Alternate Requirements**

The embedded flaw repair method will be used as an alternative to 1995/1996 Addenda ASME Section XI and 1989 Section III Code requirements.

Specifically, alternatives are being proposed for the following parts of ASME Section III, NB-4453, "Requirements for Making Repairs of Welds":

NB-4453.1 addresses defect removal and requires magnetic particle or liquid penetrant examinations of the repair excavation with acceptance criteria per NB-5340 or NB-5350. In the proposed repairs, defects will not be removed. Instead, it is proposed that the defects be embedded with a weld overlay which will prevent further growth of the defects by isolating them from the reactor coolant which might cause them to propagate by primary water stress corrosion cracking (PWSCC). Structural integrity of the affected vessel head penetration J-groove weld will be maintained by the remaining unflawed portion of the weld.

NB-4453.2 discusses requirements for welding material, procedures, and welders. The requirements of this part will be satisfied by the proposed embedded flaw repair process.

NB-4453.3 requires that the repaired areas be uniformly blended into the surrounding surface. The proposed repairs will satisfy this requirement.

NB-4453.4 stipulates that the repairs be examined in accordance with requirements for the original weld. In the proposed cases where excavation of the original weld is performed, the repairs will be subject to progressive liquid penetrant examination per the requirements of NB-5245. If no excavation is performed prior to repair welding, the weld overlay will be examined by liquid penetrant on the final surface. In both scenarios acceptance criteria will be per NB-5350.

NB-4453.5 requires the repairs be post weld heat treated per NB-4620. In the proposed cases, for repairs in the excavations that would require post weld heat treatment (PWHT) per NB-4620, a temperbead welding procedure will be used. Repairs will not require PWHT per NB- 4622.11 where the remaining thickness of original weld buttering and/or the existing cladding maintain at least 1/8 inch between the overlay weld and the ferritic base material.

The proposed repairs will involve one of two approaches. For cases where the J-groove weld has been partially excavated either to obtain a "boat" sample for analysis or in conjunction with a previously undertaken flaw exploration, the excavation will be rewelded with Alloy 52 or 152 flush with the existing weld surface, using a temperbead weld technique, if necessary. As previously described, these repairs will be examined by progressive liquid penetrant inspection. The entire weld will then be overlaid with 1/8 inch of Alloy 52 or 152 weld material. For cases where no weld excavation has occurred, the entire existing weld will be overlaid with 1/8 inch of Alloy 52 or 152 material. All final weld surfaces will be liquid penetrant inspected.

Per the 1995/1996 Addenda Edition of ASME Section XI, paragraph IWB-2200(a), a preservice examination is not required for repairs to the partial penetration J-groove pressure boundary welds between the vessel head and its penetrations (Examination Category B- P) or for the penetrations themselves. However, the NDE performed after welding will serve as a preservice examination record if needed in the future. Furthermore, the inservice inspection requirement from Table IWB-2500-1, "Examination Category B-P...," is a VT-2 visual inspection of the external surfaces of 100% of the nozzles above the reactor vessel head insulation. This inspection is performed each refueling outage as part of a system leakage test with IWB-3522 as the acceptance standard. There are no ISI requirements for the penetration tubes or repairs to the tube. Currently, we perform an augmented visual examination, VT-2, of 100% of the nozzles each refueling outage outside the reactor vessel head (RVH) insulation, looking for boric acid per Generic Letter 88-05. We also have instituted an augmented modified visual examination, VT-2, of the upper RVH under the insulation, looking for evidence of reactor coolant leakage every refueling outage . Ongoing vessel head penetration inspection activities undertaken as a result of NRC Bulletin 2001-01, Bulletin 2002-01 and ongoing deliberations in Code committees will be monitored to determine the necessity to perform any additional or augmented inspections.

Relative to the need for successive examinations in accordance with IWB-2420, we have concluded that no such examinations are required by the Code, as discussed above. Regardless of the applicability of the ASME Code article, it is important to ensure that the repair is effective in isolating the cracking from the PWR environment permanently. The first step in ensuring this is the choice of a weld material not susceptible to PWSCC, which has been done with the Alloy 52/152 weldment. After the weld repair is completed, its integrity is verified by liquid penetrant inspection.

There are no known mechanisms for any further potential cracking of the weld used to embed the flaw, or the surrounding region, except for fatigue. As mentioned earlier, the calculated fatigue usage in this region is very low, because the reactor vessel head region is isolated from the transients that affect the hot leg or cold leg piping. The thickness of the repair weld has been set to provide a permanent embedment of the flaw, without adding sufficient weld to significantly increase the residual stresses. This ensures that the embedded flaw repair will not affect areas nearby to the repair.

Therefore, there is no need for follow-up inspections of the repaired area from a technical point of view. However, we consider it prudent to demonstrate the effectiveness of the repairs. Therefore, for the proposed embedded flaw repairs involving the J-groove weld, we will perform an ultrasonic examination of the OD of the penetration immediately above the weld in the next inspection period to verify that no OD connected circumferential flaws exist and will perform a liquid penetrant inspection of the weld overlays.

Using the provisions of this relief request as an alternative to Code requirements will produce sound, permanent repairs and an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

VI. References

1. WCAP-13998, Rev. 1, "RV Closure Head Penetration Tube ID Weld Overlay Repair," March 1994

2. VEPCO Letter to NRC from James P. O'Hanlon, "Virginia Electric and Power Company, North Anna Power Station Unit 1, Reactor Vessel Head Penetrations Use of an Alternative Repair Technique," Serial Number 95-605, November 22, 1995

3. VEPCO Letter to NRC from James P. O'Hanlon, "Virginia Electric and Power Company, North Anna Power Station Unit 1, Reactor Vessel Head Penetrations Supplemental Information For Use of an Alternative Repair Technique," Serial Number 95-605A, January 26, 1996

4. NRC SER to J. P. O'Hanlon from David B. Matthews, "North Anna Unit 1- Use of an Alternate Repair Technique for Reactor Vessel Head Penetrations," Serial Number 96-079, February 5, 1996

5. VEPCO Letter to the NRC from Leslie N. Hartz , "Virginia Electric and Power Company, North Anna Power and Surry Power Stations - Response to NRC Bulletin 2001-01, Circumferential Cracking Of Reactor Vessel Head Penetration Nozzles," Serial Number 01-490, August 31, 2001

6. WCAP-15268, Rev. 1, "Aging Management Review and Time Limited Aging Analysis for the Surry Units 1 and 2 Reactor Pressure Vessels," September 2001

7. WCAP-15269, Rev. 1, "Aging Management Review and Time Limited Aging Analysis for the North Anna Units 1 and 2 Reactor Pressure Vessels," September 2001

8. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique NDE-048 and NDE-049," Serial No. 01-638, dated October 18, 2001

9. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique, Serial No. 01-638A, dated, November 9, 2001

10. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique, " Serial No. 01-638B, dated November 16, 2001

11. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique," Serial No. 01-638C, dated November 29, 2001

12. WCAP-14552, Rev. 2, "Structural Integrity Evaluation of Reactor Vessel Head Penetrations to Support Continued Operation: North Anna and Surry Units"

13. TR-109136, "Crack Growth and Microstructrual Characterization of Alloy 600 PWR Vessel Head Penetration Materials, " EPRI, December 1997

14. WCAP-15777, "Metallurgical Investigation of Cracking of the Alloy 82/182 J-Groove Weld of the Reactor Vessel Head Penetration Joint at North Anna Unit 2 Station," issued January 2002

15. Attachment 1 to Donald C. Cook Nuclear Plant Unit 2, Additional Information Requested by Nuclear Regulatory Commission Bulletin 2001-01, AEP:NRC:2054, Docket Number 50-316, March 28, 2002, Westinghouse Report WDI-RVHP-002, "D.C. Cook 2 Reactor Vessel Head Penetration Inspection Final Report, dated March 20, 2002

Attachment 2

Relief Request CMP-17
Weld Repair of Reactor Vessel Head Penetrations

North Anna Unit 2
Virginia Electric and Power Company
(Dominion)

REQUEST TO USE AN ALTERNATIVE TO ASME CODE
AMBIENT TEMPERATURE TEMPERBEAD WELD REPAIR
NORTH ANNA POWER STATION UNIT 2 RELIEF REQUEST CMP-17

I. Identification of Components

Drawing: 12050-WMKS-RC-R-1.2 Class 1

Control rod drive mechanism (CRDM) penetrations (65) and the reactor head vent (1) on the upper reactor vessel head, which are ASME Class 1 components.

II. Current Code Requirements

The Construction Code of record for the North Anna reactor vessels and heads is the 1968 Edition of ASME Section III with Addenda through the winter of 1968. North Anna Unit 2 is currently in its third inspection interval using the 1995 Edition/1996 Addenda of ASME Section XI. ASME Section XI, paragraph IWA-4221, "Construction Code and Owner's Requirements," stipulates the following:

(c) "An item to be used for repair/replacement activities shall meet the Owner's Requirements and the applicable Construction Code to which the original item was constructed, except as provided in IWA-4221 (b) and (c).

(d) The item may meet all or portions of the requirements of different Editions and Addenda of the Construction Code, or Section III when the Construction Code was not Section III, provided the requirements of IWA-4222 through IWA-4226, as applicable, are met. Construction Code Cases may also be used. A Report of Reconciliation, if required, shall be prepared. All or portions of later different Construction Codes may be used ..."

Consequently, the proposed repairs will be conducted in accordance with the 1989 Edition of ASME III and alternative requirements discussed below.

III. Code Requirements for Which Alternatives Are Requested

Subparagraph IWA-4611.1, requires the repair of any flaw associated with the J-groove weld attaching the penetration to the head which cannot be accepted by the rules of the original Construction Code. Per paragraph IWA- 4221, repair welding must be done in accordance with the original Construction Code. Therefore, for any J-groove weld excavation that resulted in a repair within 1/8-inch of the ferritic material of the vessel head, paragraph NB-4622 of Section III would require a stress relief postweld heat treatment (PWHT) for the repair weld or the use of a temperbead weld technique. The PWHT parameters required by NB-4622 would be difficult to achieve on a reactor vessel head in containment and pose some risk of distortion to the geometry of the head and vessel head penetrations. The temperbead procedure requirements, including preheat and postweld heat soaks contained in NB-4622, likewise would be difficult to achieve in containment and are not warranted by the need to produce a sound repair weld given the capabilities of the proposed alternative temperbead procedure proposed below.

Specifically, alternatives are being proposed for the following subparagraphs of ASME Section III, NB-4622:

NB-4622.1 establishes the requirement for post weld heat treatment (PWHT) of welds including repair welds. In lieu of the requirements of this subparagraph, we propose to utilize a temperbead weld procedure obviating the need for post weld stress relief.

NB-4622.2 establishes requirements for time at temperature recording of the PWHT and their availability for review by the inspector. This requirement of this subparagraph will not apply because the proposed alternative repair weld does not involve PWHT.

NB-4622.3 discusses the definition of nominal thickness as it pertains to time at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative repair weld involves no PWHT.

NB-4622.4 establishes the holding times at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative repair weld involves no PWHT.

NB-4622.5 establishes PWHT requirements when different P-number materials are joined. This subparagraph is not applicable because the proposed alternative repair weld involves no PWHT.

NB-4622.6 establishes PWHT requirements for nonpressure retaining parts. The subparagraph is not applicable in this case because the potential repairs in question will be to pressure retaining parts. Furthermore, the proposed alternative repair weld involves no PWHT.

NB-4622.7 established exemptions from mandatory PWHT requirements. Subsubparagraphs 4622.7(a) through 4622.7(f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Subsubparagraph 4622.7(g) discusses exemptions to repair welds to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. The ambient temperature temperbead repair is being proposed as an alternative repair weld to the requirements of subparagraph NB-4622.11.

NB-4622.8 establishes exemptions from PWHT for nozzle to component welds and branch connection to run piping welds. Subsubparagraph 4622.8(a) establishes criteria for exemption of PWHT for partial penetration welds. This is not applicable to the proposed repairs because the criteria involve buttering layers at least ¼ inch thick, which will not exist for the repair welds. Subsubparagraph 4622.8(b) also does not apply because it discusses full penetration welds and the repair welds are partial penetration welds.

NB-4622.9 establishes requirements for temperbead repairs to P-No. 1 and P-No. 3 materials and A-Nos. 1, 2, 10, or 11 filler metals. This subparagraph does not apply because the proposed repair welds will involve F-No. 43 filler metals using gas tungsten arc welding (GTAW) instead of shielded metal arc welding (SMAW).

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

NB-4622.11 discusses temperbead repair welds to dissimilar metal welds or buttering and would apply to the proposed repair welds.

Subsubparagraph NB-4622.11(a) requires surface examination prior to repair in accordance with NB-5000. The proposed alternative repair weld will include surface examination prior to weld repair consistent with NB-5000. The acceptance criteria for the surface examination may not meet NB-5350 if an embedded flaw approach is utilized. When the embedded flaw approach is utilized, the surface examination acceptance criteria shall be consistent with the criteria for the structural flaw evaluation acceptance documented in WCAP-14552, Revision 2 (Reference 13). Utilization of the embedded flaw approach is proposed separately in relief request CMP-16.

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

- Subsubparagraph NB-4622.11(c) discusses the repair welding procedure and requires procedure and welder qualification in accordance with ASME Section IX and the additional requirements of Article NB-4000. The proposed alternative weld repair will satisfy this requirement. In addition, NB-4622.11(c) requires that the Welding Procedure Specification include the following requirements:

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

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

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

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

- NB-4622.11(c)(5) requires that a 350°F preheat and 450°F interpass temperature be utilized for repair welding. Additionally it states that thermocouples shall be utilized for monitoring these temperatures. The proposed ambient temperature temperbead alternative does not require elevated temperature preheat. Instead a 50°F minimum preheat will be used. Maximum interpass temperature for the proposed alternative repair weld is limited to 150°F for the first three layers and 350°F, thereafter. Non-contact pyrometers will be used to monitor the metal temperature while welding in lieu of thermocouples.

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

- NB-4622.11(c)(7) requires the preheated area to be heated to 450°F to 660°F for 4 hours after a minimum of 3/16 inch of weld metal has been deposited. The proposed alternative repair weld does not require this heat treatment because the use of the extremely low hydrogen GTAW temperbead procedure does not require the hydrogen bake out.

- NB-4622.11(c)(8) requires welding, subsequent to the hydrogen bake out of NB-4622.11(c)(7), be done with a minimum preheat of 100°F and maximum interpass temperature of 350°F. The proposed alternative uses a 50°F minimum preheat and limits the interpass temperature to 150°F for the first three layers and 350°F, thereafter. These limitations have been demonstrated to be adequate to produce sound welds.

- NB-4622.11(d)(1) requires a liquid penetrant examination after the hydrogen bake out described in NB-4622.11(c)(7). The proposed alternative repair weld does not require the hydrogen bake out but will include the in-process liquid penetrant examination at the lesser of ½ of the weld thickness or ½ inch.

- NB-4622.11(d)(2) requires liquid penetrant and radiographic examinations of the repair welds after a minimum time of 48 hours at ambient temperature. Ultrasonic inspection is required if practical. The proposed repair weld includes the requirement to inspect after a minimum of 48 hours at ambient temperature. Because the proposed repair welds are of a configuration that cannot be radiographed, the final inspection will be by liquid penetrant and ultrasonic inspection, if practical.

- NB-4622.11(d)(3) requires that all nondestructive examinations shall be in accordance with NB-5000. The proposed alternative will comply with that requirement.

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

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

- NB-4622.11(g) establishes requirements for welder performance qualification relating to physical obstructions that might impair the welder's ability to make sound repairs which is particularly pertinent to the SMAW manual welding process. The proposed alternative repair weld involves a machine GTAW process and requires welding operators be qualified in accordance with ASME Section IX. The use of a machine process eliminates concern about obstructions, which might interfere with the welder's abilities since these obstructions will have to be eliminated to accommodate the welding machine.

Subparagraph NB-4453.1 of Section III requires removal of the defect in the repair cavity and for the cavity to receive a surface examination utilizing the acceptance standards of NB-5350. The acceptance criteria for the surface examination may not meet NB-5350 if an embedded flaw approach is utilized. When the embedded flaw approach is utilized, the surface examination acceptance criteria shall be consistent with the criteria for the structural flaw evaluation acceptance documented in WCAP-14552, Revision 2 (Reference 13). Utilization of the embedded flaw approach is proposed separately in relief request CMP-16.

Subparagraph NB-4453.4 of Section III requires examination of the repair weld in accordance with the requirements for the original weld. For vessel head penetration partial penetration welds, paragraph NB-5245 requires a progressive surface exam (PT or MT) at the lesser of ½ the maximum weld thickness or ½-inch, as well as on the finished weld. The repair weld will be examined per NB-5245.

IV. Basis for Relief

The alternative to NB-4622 requirements being proposed involves the use of an ambient temperature temperbead welding technique that avoids the necessity of traditional PWHT preheat and postweld heat soaks. The features of the alternative that make it applicable and acceptable for the contemplated repairs are discussed below:

1) The proposed alternative repair weld will require the use of an automatic or machine gas tungsten arc welding (GTAW) temperbead technique without the specified preheat or postweld heat treatment of the Construction Code. The proposed alternative will include the requirements of paragraphs 1.0 through 5.0 of Enclosure 1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temperbead Technique," and specifies that all other requirements of IWA-4000 be met. The alternative repair weld may be used to make repairs to P-Nos. 1, 3, 12A, 12B, and 12C (except SA-302 Grade B) material and their associated welds, and P-No. 8 and P-No. 43 material to P-Nos. 1, 3, 12A, 12B, and 12C (except SA-302 Grade B) material. In this case, the reactor vessel head is a P-No. 3 material and the affected welds are those J-groove welds attaching the P-No. 43 vessel head penetrations to the vessel head. The J-groove welds were made with F-No. 43 filler metal.

2) The use of a GTAW temperbead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by EPRI and other organizations (Reference 12). The research demonstrates that carefully controlled heat input and bead placement allow subsequent welding passes to relieve stress and temper the heat affected zones (HAZ) of the base material and preceding weld passes. Data presented in Tables 4-1 and 4-2 of the report show the results of procedure qualifications performed with 300°F preheats and 500°F postheats, as well as with no preheat and postheat. From that data, it is clear that equivalent toughness is achieved in base metal and heat affected zones in both cases. The temperbead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed. Many acceptable Procedure Qualifications Reports (PQRs) and Welding Procedure Specifications (WPSs) presently exist and have been used to perform numerous successful repairs. These repairs have included all of the Construction Book Sections of the ASME Code, as well as the National Board Inspection Code (NBIC). The use of the automatic or machine GTAW process utilized for temperbead welding allows more precise control of heat input, bead placement, and bead size and contour than the manual shielded metal arc welding (SMAW) process required by NB-4622. The very precise control over these factors afforded by the alternative repair weld provides more effective tempering and eliminates the need to grind or machine the first layer of the repair.

3) The NB-4622 temperbead procedure requires a 350°F preheat and a postweld

soak at 450°-550°F for 4 hours for P-No. 3 materials. Typically, these kinds of restrictions are used to mitigate the effects of the solution of atomic hydrogen in ferritic materials prone to hydrogen embrittlement cracking. The susceptibility of ferritic steels is directly related to their ability to transform to martensite with appropriate heat treatment. The P-No. 3 material of the reactor vessel head is able to produce martensite from the heating and cooling cycles associated with welding. However, the proposed alternative repair weld mitigates this propensity without the use of elevated preheat and postweld hydrogen bake out.

The NB-4622 temperbead procedure requires the use of the SMAW welding process with covered electrodes. Even the low hydrogen electrodes, which are required by NB-4622, may be a source of hydrogen unless very stringent electrode baking and storage procedures are followed. The only shielding of the molten weld puddle and surrounding metal from moisture in the atmosphere (a source of hydrogen) is the evolution of gases from the flux and the slag that forms from the flux and covers the molten weld metal. As a consequence of the possibility for contamination of the weld with hydrogen, NB-4622 temperbead procedures require preheat and postweld hydrogen bake-out. However, the proposed alternative temperbead procedure utilizes a welding process that is inherently free of hydrogen. The GTAW process relies on bare welding electrodes with no flux to absorb moisture. An inert gas blanket positively shields the weld and surrounding material from the atmosphere and moisture it may contain. To further reduce the likelihood of any hydrogen evolution or absorption, the alternative repair weld procedure requires particular care to ensure the weld region is free of all sources of hydrogen. The GTAW process will be shielded with welding grade argon (99.9996% pure) which typically produces porosity free welds. The gas would have no more than 1 PPM of hydrogen (H_2) and no more than 0.5 PPM of water vapor (H_2O). A typical argon flow rate would be about 55 CFH and would be adjusted to assure adequate shielding of the weld without creating a venturi affect that might draw oxygen or water vapor from the ambient atmosphere into the weld.

After the electrical discharge machining (EDM) process is used to prepare the excavation for welding, the repair excavation and surrounding area would be cleaned by wire brushing to assure it is free of dust, sediments, oxides, boric acid residue, etc. Quartz halogen heat lamps would then be used to heat the area and ensure it is moisture free.

4) The F-No. 43 (ERNiCrFe-7) filler metal that would be used for the repairs is not subject to hydrogen embrittlement cracking.

5) Final examination of the repair welds would be a surface examination and would not be conducted until at least 48 hours after the weld had returned to ambient temperature following the completion of welding. Given the 3/8-inch limit on repair depth in the ferritic material, the delay before final examination would provide ample time for any hydrogen that did inadvertently dissolve in the ferritic

material to diffuse into the atmosphere or into the nonferritic weld material which has a higher solubility for hydrogen and is much less prone to hydrogen embrittlement cracking. Thus, in the unlikely event that hydrogen induced cracking did occur, it would be detected by the 48-hour delay in examination.

6) Results of procedure qualification work undertaken to date indicate that the proposed alternative produces sound and tough welds. For instance, typical tensile test results have been ductile breaks in the weld metal. A typical set of Charpy test values showed average absorbed energies and lateral expansions of 76 ft.-lbs. and 45 mils for the base metal (a P-No. 3 Gr. 3 material), 114 ft.-lbs. and 57 mils for the heat affected zone, and 254 ft.-lbs. and 84 mils for the weld metal (a F-No. 43 filler metal). It is clear from these results that the ambient temperature GTAW temperbead process has the capability of producing acceptable repair welds.

7) Procedure qualification, performance qualification, welding procedure specifications, examination, and documentation requirements would be as stipulated in the proposed alternative procedure.

Based on the above information it may be concluded that the proposed alternative ambient temperature temperbead weld technique (Enclosure 1) provides a technique for repairing flaws in the CRDM and reactor head vent penetration to vessel head J-groove welds within 1/8-inch of the ferritic base metal that will produce sound and permanent repairs and that the procedure is an alternative to Code requirements that will provide an acceptable level of quality and safety.

Therefore, a temperbead repair weld is considered to be an alternative to Code requirements that provides an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

V. Alternate Requirements

Repairs to reactor vessel head penetration J-groove attachment welds, which are required when 1/8-inch or less of nonferritic weld deposit exists above the original fusion line, will be made in accordance with the requirements of paragraphs IWA-4110 (Scope), 4220 (Code Applicability), 4150 (Repair/Replacement Program and Plan), 4170 (Inspection), 4430 (Storage and Handling of Weld Materials), 4611 (Metal Removal), 4440 (Welding and Welder Qualification (Including Welding Operators)), 4500 (Examination and Test), and 4180 (Documentation) of the 1995 Edition/1996 Addenda of ASME Section XI.

The requirements of paragraphs NB-4451, 4452, 4453, and 4622 of the 1989 Edition of ASME Section III are also applicable to the contemplated repairs. As an alternative to the PWHT time and temperature requirements of NB-4622, the requirements of, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temperbead Technique," (Enclosure 1) will be used. Specifically, alternatives are being proposed for the following subparagraphs of ASME Section III, NB-4622:

NB-4622.1 establishes the requirement for post weld heat treatment (PWHT) of welds including repair welds. In lieu of the requirements of this subparagraph, we propose to utilize a temperbead weld procedure obviating the need for post weld stress relief.

NB-4622.2 establishes requirements for time at temperature recording of the PWHT and their availability for review by the inspector. This requirement of this subparagraph does not apply because the proposed alternative does not involve PWHT.

NB-4622.3 discusses the definition of nominal thickness as it pertains to time at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative involves no PWHT.

NB-4622.4 establishes the holding times at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative involves no PWHT.

NB-4622.5 establishes PWHT requirements when different P-number materials are joined. This subparagraph is not applicable because the proposed alternative involves no PWHT.

NB-4622.6 establishes PWHT requirements for nonpressure retaining parts. The subparagraph is not applicable in this case because the potential repairs in question will be to pressure retaining parts. Furthermore, the proposed alternative involves no PWHT.

NB-4622.7 establishes exemptions from mandatory PWHT requirements. Subsubparagraphs 4622.7(a) through 4622.7(f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repair welds. Subsubparagraph 4622.7(g) discusses exemptions to repair welds to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. This subsubparagraph does not apply because the ambient temperature temperbead repair is being proposed as an alternative to the requirements of subparagraph NB-4622.11.

NB-4622.8 establishes exemptions from PWHT for nozzle to component welds and branch connection to run piping welds. Subsubparagraph 4622.8(a) establishes criteria for exemption of PWHT for partial penetration welds. This is not applicable to the proposed repair welds because the criteria involve buttering layers at least ¼ inch thick, which will not exist for the repair welds. Subsubparagraph 4622.8(b) also does not apply because it discusses full penetration welds and the repair welds are partial penetration welds.

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

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

NB-4622.11 discusses temperbead repair welds to dissimilar metal welds or buttering and would apply to the proposed repair welds as follows.

- Subsubparagraph NB-4622.11(a) requires surface examination prior to repair in accordance with NB-5000. The proposed alternative repair weld will include surface examination prior to repair consistent with NB-5000. The acceptance criteria for the surface examination may not meet NB-5350 if an embedded flaw approach is utilized. When the embedded flaw approach is utilized, the surface examination acceptance criteria shall be consistent with the criteria for the structural flaw evaluation acceptance documented in WCAP-14552, Revision 2 (Reference 13). Utilization of the embedded flaw approach is proposed separately in relief request CMP-16.

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

- Subsubparagraph NB-4622.11(c) discusses the repair welding procedure and welder qualification in accordance with ASME Section IX and the additional requirements of Article NB-4000. The proposed alternative repair weld will satisfy these requirements. In addition, NB-4622.11(c) requires the welding procedure specification include the following requirements:

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

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

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

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

- NB-4622.11(c)(5) requires that a 350°F preheat and 450°F interpass temperature be utilized for repair welding. Additionally it states that thermocouples shall be utilized for monitoring these temperatures. The proposed ambient temperature temperbead alternative does not require elevated temperature preheat. Instead a 50°F minimum preheat will be used. Maximum interpass temperature for the proposed alternative is limited to 150°F for the first three layers and 350°F, thereafter. Non-contact pyrometers will be used to monitor the metal temperature while welding in lieu of thermocouples.

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

- NB-4622.11(c)(7) requires the preheated area to be heated from 450°F to 660°F for 4 hours after a minimum of 3/16 inch of weld metal has been deposited. The proposed alternative does not require this heat treatment because the use of the extremely low hydrogen GTAW temperbead procedure does not require the hydrogen bake out.

- NB-4622.11(c)(8) requires welding subsequent to the hydrogen bake out of NB-4622.11(c)(7) be done with a minimum preheat of 100°F and maximum interpass temperature of 350°F. The proposed alternative repair weld uses a 50°F minimum preheat and limits the interpass temperature to 150°F for the first three layers and 350°F thereafter. These limitations have been demonstrated to be adequate to produce sound welds.

- NB-4622.11(d)(1) requires a liquid penetrant examination after the hydrogen bake out described in NB-4622.11(c)(7). The proposed alternative repair weld does not require the hydrogen bake out, but will include in process liquid penetrant examination at the lesser of ½ of the weld thickness or ½ inch.

- NB-4622.11(d)(2) requires liquid penetrant and radiographic examinations of the repair welds after a minimum time of 48 hours at ambient temperature. Ultrasonic inspection is required if practical. The proposed alternative repair weld includes the requirement to inspect after a minimum of 48 hours at ambient temperature. Because the proposed repair welds are of a configuration that cannot be radiographed, the final inspection will be by liquid penetrant and ultrasonic inspection, if practical.

- NB-4622.11(d)(3) requires that all nondestructive examination shall be in accordance with NB-5000. The proposed alternative will comply with that requirement.

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

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

- NB-4622.11(g) establishes requirements for welder performance qualification relating to physical obstructions that might impair the welder's ability to make sound repairs which is pertinent to the SMAW manual welding process. The proposed alternative repair weld involves a machine GTAW process and requires welding operators be qualified in accordance with ASME Section IX. The use of a machine process eliminates any concern about obstructions, which might interfere with the welder's abilities because all such obstructions will have to be eliminated to accommodate the welding machine.

Per 1995 Edition/1996 Addenda of ASME Section XI, Subparagraph IWB-2200(a), no preservice examination is required for repairs to the partial penetration J-groove pressure boundary welds between the vessel head and its penetrations (Examination Category B-P) or for the penetrations themselves. However, the NDE performed after welding will serve as a preservice examination record if needed in the future. Furthermore, the inservice inspection requirement from Table IWB-2500-1, "Examination Category B-P...," is a VT-2 visual inspection of the external surfaces of 100% of the nozzles above the reactor vessel head insulation each refueling outage with IWB-3522 as the acceptance standard. There are no ISI requirements for the penetration tubes or repairs to the tubes. Currently, we perform an augmented visual examination, VT-2, of 100% of the reactor vessel penetration nozzles each refueling outage above the head insulation, looking for boric acid per Generic Letter 88-05. We also have instituted an augmented modified visual examination, VT-2, of the upper RVH under the insulation, looking for evidence of reactor coolant leakage every refueling outage consistent with our response to NRC Bulletin 2001-01. Ongoing vessel head penetration inspection activities undertaken as a result of NRC Bulletin 2001-01, Bulletin 2002-01 and ongoing deliberations in Code committees will be monitored to determine the necessity of performing any additional or augmented inspections.

Using the provisions of this relief request as an alternative to Code requirements will produce sound, permanent repair welds and an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

VI References

1. WCAP-13998, "RV Closure Head Penetration Tube ID Weld Overlay Repair," March 1994

2. VEPCO Letter to NRC from James P. O'Hanlon, "Virginia Electric and Power Company, North Anna Power Station Unit 1, Reactor Vessel Head Penetrations Use of an Alternative Repair Technique," Serial Number 95-605, November 22, 1995

3. VEPCO Letter to NRC from James P. O'Hanlon, "Virginia Electric and Power Company, North Anna Power Station Unit 1, Reactor Vessel Head Penetrations Supplemental Information For Use of an Alternative Repair Technique," Serial Number 95-605A, January 26, 1996

4. NRC SER to J. P. O'Hanlon from David B. Matthews, "North Anna Unit 1- Use of an Alternate Repair Technique for Reactor Vessel Head Penetrations," Serial Number 96-079, February 5, 1996

5. VEPCO Letter to the NRC from Leslie N. Hartz , "Virginia Electric and Power Company, North Anna Power and Surry Power Stations - Response to NRC Bulletin 2001-01, Circumferential Cracking Of Reactor Vessel Head Penetration Nozzles," Serial Number 01-490, August 31, 2001

6. WCAP-15268, Rev. 1, "Aging Management Review and Time Limited Aging Analysis for the Surry Units 1 and 2 Reactor Pressure Vessels," September 2001

7. WCAP-15269, Rev. 1, "Aging Management Review and Time Limited Aging Analysis for the North Anna Units 1 and 2 Reactor Pressure Vessels," September 2001

8. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique," Serial No. 01-638, dated October 18, 2001

9. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique," Serial No. 01-638A, dated November 9, 2001

10. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique," Serial No. 01-638B, dated November 16, 2001

11. VEPCO Letter to NRC from Leslie N. Hartz, "Virginia Electric and Power Company,

Surry and North Anna Power Station Units 1, ASME Section XI Inservice Inspection Program Revised Relief requests Alternative Repair Technique," Serial No. 01-638C, dated November 29, 2001

12. EPRI report entitled "Ambient Temperbead Preheat for Machine GTAW Temperbead Applications," EPRI Report GC-111050, issued November 1998

13. WCAP-14552, "Structural Integrity Evaluation of Reactor Vessel Head Penetrations to Support Continued Operation: North Anna and Surry Units," Rev. 2

Enclosure 1

Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temperbead Technique

The following proposed alternative to Code requirements contained in paragraph NB-4622 of the 1989 Edition of Section III applies to repairs to P-Nos. 1, 3, 12A, 12B, and 12C (P-Nos. 12A, 12B, and 12C designations refer to specific material classifications originally identified in Section III and subsequently reclassified as P-No. 3 material in a later Edition of Section IX) except SA-302 Grade B, material and their associated welds and P-No. 8 or P-No. 43 material to P-Nos. 1, 3, 12A, 12B, and 12C, except SA-302 Grade B, material and may be made by the automatic or machine GTAW temperbead technique without the specified preheat or postweld heat treatment of the Construction Code, provided the requirements of paragraphs 1.0 through 5.0, below and all other requirements of IWA-4000 in the 1995 Edition/1996 Addenda of ASME Section XI and earlier Editions and Addenda, are met. The technical basis for the proposed alternative is Reference 12, a previously docketed EPRI report entitled "Ambient Temperbead Preheat for Machine GTAW Temperbead Applications," Report GC-111050, issued November 1998.

1.0 GENERAL REQUIREMENTS

(a) The maximum area of an individual weld based on the finished surface shall be 100 square inches and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.

(b) Repair/replacement activities on a dissimilar-metal weld in accordance with this procedure are limited to those along the fusion line of a nonferritic weld to ferritic base material on which 1/8 inch, or less of nonferritic weld deposit exists above the original fusion line.

(c) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed in accordance with these requirements, provided the depth of repair in the base material does not exceed 3/8 in.

(d) Prior to welding, the area to be welded and a band around the area of at least 1 and ½ times the component thickness or 5-inches, whichever is less, shall be at least 50°F.

(e) Welding materials shall meet the Owner's Requirements and the Construction Code and Cases specified in the Repair/Replacement Plan. Welding materials shall be controlled so that they are identified as acceptable until consumed.

(f) Peening may be used, except on the initial and final layers.

2.0 WELDING QUALIFICATIONS

The welding procedures and the welding operators shall be qualified in accordance with Section IX and the requirements of paragraphs 2.1 and 2.2.

2.1 Procedure Qualification

(a) The base materials for the welding procedure qualification shall be of the same P-Number and Group Number as the materials to be welded. The materials shall be postweld heat treated for at least the time and temperature that was applied to the materials being welded.

(b) Consideration shall be given to the effects of welding in a pressurized environment. If they exist, they shall be duplicated in the test assembly.

(c) Consideration shall be given to the effects of irradiation on the properties of material, including weld material for applications in the core belt line region of the reactor vessel. Special material requirements in the design specification shall also apply to the test assembly materials for these applications.

(d) The root width and included angle of the cavity in the test assembly shall be no greater than the minimum specified for the repair.

(e) The maximum interpass temperature for the first three layers of the test assembly shall be 150°F.

(f) The test assembly cavity depth shall be at least one-half the depth of the weld to be installed during the repair/replacement activity and at least 1-inch. The test assembly thickness shall be at least twice the test assembly cavity depth. The test assembly shall be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity shall be at least the test assembly thickness and at least 6-inches. The qualification test plate shall be prepared in accordance with Figure 1.

(g) Ferritic base material for the procedure qualification test shall meet the impact test requirements of the Construction Code and Owner's Requirements. If such requirements are not in the Construction Code and Owner's Requirements, the impact properties shall be determined by Charpy V-notch impact tests of the procedure qualification base material at or below the lowest service temperature of the item to be repaired. The location and orientation of the test specimens shall be similar to those required in (i) below, but shall be in the base metal.

(h) Charpy V-notch tests of the ferritic weld metal of the procedure qualification shall meet the requirements as determined in (g) above.

(i) Charpy V-notch tests of the ferritic heat-affected zone (HAZ) shall be performed at the same temperature as the base metal test of (g) above. Number, location, and orientation of test specimens shall be as follows:

(1) The specimens shall be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The coupons for HAZ impact specimens shall be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much HAZ as possible in the resulting fracture. When the material thickness permits, the axis of a specimen shall be inclined to allow the root of the notch to be aligned parallel to the fusion line.

(2) If the test material is in the form of a plate or a forging, the axis of the weld shall be oriented parallel to the principal direction of rolling or forging.

(3) The Charpy V-notch test shall be performed in accordance with SA-370. Specimens shall be in accordance with SA-370, Figure 11, Type A. The test shall consist of a set of three full-size 10-mm x 10-mm specimens. The lateral expansion, percent shear, absorbed energy, test temperature, orientation and location of all test specimens shall be reported in the Procedure Qualification Record.

(j) The average values of the three HAZ impact tests shall be equal to or greater than the average of the three unaffected base metal tests.

2.2 Performance Qualification

Welding operators shall be qualified in accordance with Section IX.

3.0 WELDING PROCEDURE REQUIREMENTS

The welding procedure shall include the following requirements:

(a) The automatic or machine GTAW process shall deposit the weld metal.

(b) Dissimilar metal welds shall be made using A-No. 8 weld metal (QW-442) for P-No. 8 to P-No. 1, 3, or 12 (A, B, or C) weld joints or F-No. 43 weld metal (QW-432) for P-No. 8 or 43 to P-No. 1, 3, or 12 (A, B, or C) weld joints.

(c) The area to be welded shall be buttered with a deposit of at least three layers to achieve at least 1/8-inch overlay thickness, as shown in Figure 2, Steps 1 through 3, with the heat input for each layer controlled to within ± 10% of that used in the procedure qualification test. Particular care shall be taken in placement of the weld layers at the weld toe area of the ferritic material to ensure that the HAZ and ferritic weld metal are tempered. Subsequent layers shall be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification. For similar metal welding, the completed weld shall have at least one layer of weld reinforcement deposited. This reinforcement shall be removed by mechanical means, so that the finished surface is essentially flush with the surface surrounding the weld as depicted in Figure 3.

(d) The maximum interpass temperature for field applications shall be 350°F regardless of the interpass temperature during qualification.

(e) Particular care shall be given to ensure that the weld region is free of all potential sources of hydrogen. The surfaces to be welded, filler metal, and shielding gas shall be suitably controlled.

4.0 EXAMINATION

(a) Prior to welding, a surface examination shall be performed on the area to be welded.

(b) When excavations with existing indications are embedded using the temperbead technique, the repair weld will be inspected by liquid penetrant (PT) at ½ the excavation depth or ½ inch, whatever is less, and on the final layer prior to overlaying the J-groove weld with Alloy 52. The final weld surface and the band around the area defined in paragraph 1.0(d) shall be examined using a liquid penetrant method when the completed weld has been at ambient temperature for at least 48 hours.

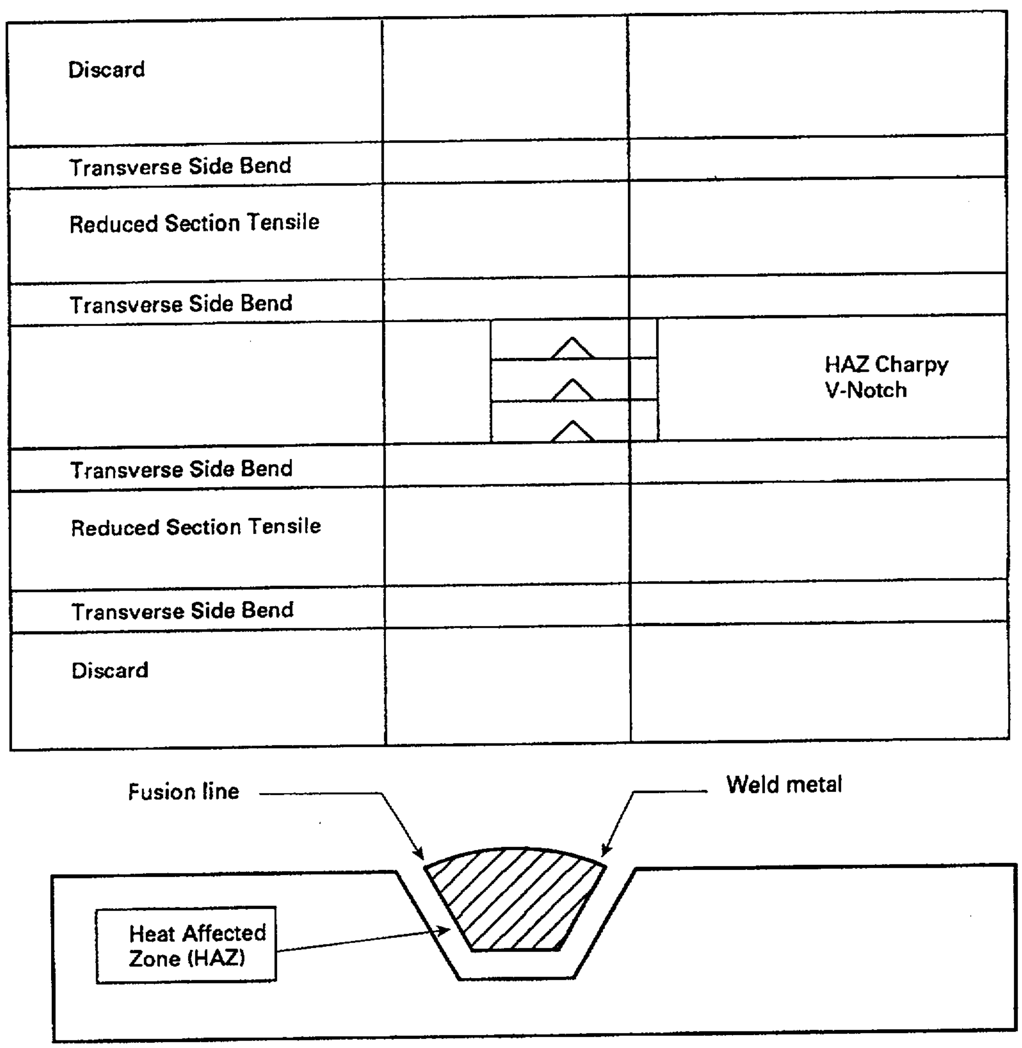
(c) Areas from which weld-attached thermocouples have been removed shall be ground and examined using a surface examination method.

(d) NDE personnel shall be qualified in accordance with IWA-2300.

(e) Surface examination acceptance criteria shall be in accordance with NB-5350. When embedding flaws the acceptance criteria for the surface exam performed prior to welding shall be consistent with the criteria for the structural flaw evaluation acceptance documented in WCAP-14552, Revision 2 (Reference 13).

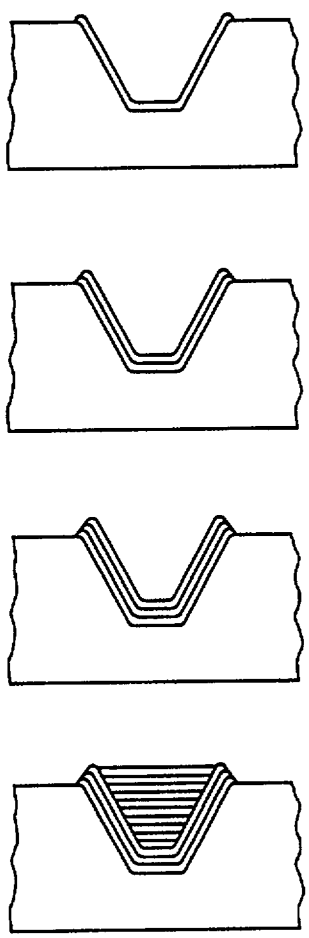
5.0 DOCUMENTATION

The use of this procedure to conduct repairs shall be documented on Form NIS-2A.



GENERAL NOTE: Base metal Charpy impact specimens are not shown. This figure illustrates a similar-metal weld.

FIG. 1 QUALIFICATION TEST PLATE



Step 1: Deposit layer one with first layer weld parameters used in qualification.

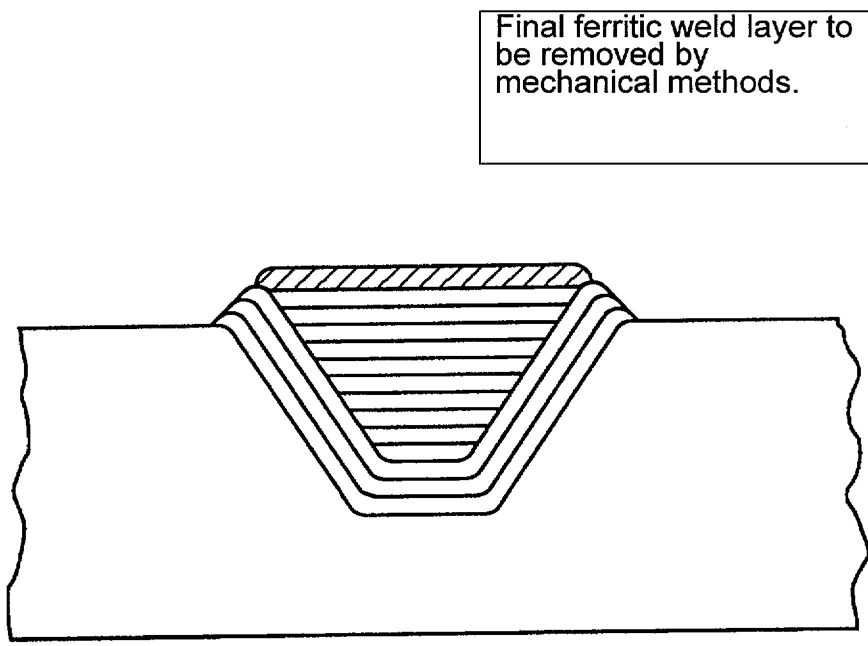
Step 2: Deposit layer two with second layer weld parameters used in qualification. NOTE: Particular care shall be taken in application of the second layer at the weld toe to ensure that the weld metal and HAZ of the base metal are tempered.

Step 3: Deposit layer three with third layer weld parameters used in qualification. NOTE: Particular care shall be taken in application of the third layer at the weld toe to ensure that the weld metal and HAZ of the base metal are tempered.

Step 4: Subsequent layers to be deposited as qualified, with heat input less than or equal to that qualified in the test assembly. NOTE: Particular care shall be taken in application of the fill layers to preserve the temper of the weld metal and HAZ.

GENERAL NOTE: The illustration above is for similar-metal welding using a ferritic filler material. For dissimilar-metal welding, only the ferritic base metal is required to be welded using steps 1 through 3 of the temperbead welding technique.

FIG. 2 AUTOMATIC OR MACHINE (GTAW)
TEMPERBEAD WELDING



GENERAL NOTE: For ferritic filler metals the completed weld shall have at least one layer of weld reinforcement deposited. This reinforcement shall be removed by mechanical means, so that the finished surface of the weld is essentially flush with the surface of the component surrounding the repair.

FIG. 3 FINAL FERRITIC WELD LAYER