Dominion Nuclear Connecticut, Inc.
Millstone Power Station
Rope Ferry Road
Waterford, CT 06385

Dominion

September 15, 2003

RE: 10 CFR 50.55a(a)(3)(ii)
10 CFR 50.55a(g)(4)(iv)

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

Serial No.:	03-480
	B18984
NL&OS/PRW	Rev 0
Docket No.:	50-336
License No.:	DPR-65

Dominion Nuclear Connecticut, Inc. (Dominion)
Millstone Power Station, Unit No. 2
10 CFR 50.55a Requests RR-89-44 and RR-89-45 for Alternative Temper Bead Welding Requirements for Weld Pad Deposits and for Alternative Acceptance Standards Requirements Without Flaw Removal in Alloy 600 Small Bore Nozzles

Pursuant to 10 CFR 50.55a(a)(3)(ii), Dominion Nuclear Connecticut, Inc. (DNC), requests approval to use alternatives to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for the welding and acceptance standards that are associated with the activities surrounding performance of half-nozzle repair/replacements at Millstone Unit No. 2. Currently, these ASME Code requirements contain no provisions to either address a temper bead weld repair process or allow a flaw to remain in place when a half-nozzle repair/replacement is performed. Without the alternatives requested in Attachments 1 and 2, a hardship exists in gaining access and performing work on the inside surface of the pressurizer, steam generators and RCS piping, without a compensating increase in quality and safety. To support implementation of these alternatives, pursuant to 10 CFR 50.55a(g)(4)(iv), approval is also requested for use of a later Edition of the ASME Code Sections III and XI in lieu of the current ASME Code of Record for the pressurizer, the steam generator channel heads, and the RCS piping.

Millstone Unit No. 2 is currently in the Third 10-Year Inservice Inspection (ISI) interval, which started on April 1, 1999. The 1989 Edition of Section XI with no Addenda applies to the ISI program and is used as the primary ASME Code Edition for Section XI repair/replacement activities.

Although no specific application has been identified, these requests are being submitted for NRC review and approval to provide for contingencies in support of potential half-nozzle repair/replacements that may need to be performed in the upcoming Fall 2003 outage and future refueling outages for the remainder of the Third 10-Year Inservice Inspection (ISI) Program interval. Accordingly, DNC requests review and approval of these alternatives by October 31, 2003.

A047

There are no regulatory commitments contained within this letter.

If you should have any questions regarding this submittal, please contact Mr. David W. Dodson at (860) 447-1791, extension 2346.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

Leslie N. Hartz
Vice President – Nuclear Engineering

Attachments: (1) Request RR-89-44, Use of Alternative Temper Bead Welding Requirements
(2) Request RR-89-45, Use of Alternative Acceptance Standards Requirements Without Flaw Removal in Alloy 600 Small Bore Nozzles

cc: H. J. Miller, Region I Administrator
R. B. Ennis, NRC Senior Project Manager, Millstone Unit No. 2
Millstone Senior Resident Inspector

SNs: 03-480/B18984
Docket No. 50-336
Subject: Relief Requests RR-89-44 & RR-89-45

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President - Nuclear Engineering, of Dominion Nuclear Connecticut, Inc. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 15th day of September, 2003.

My Commission Expires: March 31, 2004.

Margaret McClure
Notary Public

(SEAL)

Attachment 1

Millstone Power Station, Unit No. 2

Request RR-89-44, Use of Alternative Temper Bead Welding
Requirements For Weld Pad Deposits

Request RR-89-44, Use of Alternative Temper Bead Welding Requirements For Weld Pad Deposits

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Request RR-89-44, Use of Alternative Temper Bead Welding
Requirements For Weld Pad Deposits

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(ii)

- Hardship or Unusual Difficulty without Compensating Increase in Level of Quality or Safety -

1.0 COMPONENT IDENTIFICATION:

Pressurizer Instrumentation Nozzles (8) - Potential Weld Pad Deposits For The Following Nozzles:

Level Nozzles (4): Four 1-inch, schedule 160 level nozzles, two in the upper head and two in the lower head, all fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Pressure Nozzles (2): Two 1-inch, schedule 160 pressure nozzles in the upper head, all fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Temperature Nozzles (2): Two 1-inch, schedule 160 temperature nozzles, one in the top head (steam space) and one in the lower shell (heater area), both fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Steam Generator Instrumentation Nozzles (8) – Potential Weld Pad Deposits For The Following Nozzles:

Steam Generator No. 1 (SG1) Instrument Pressure Tap Nozzles (4): Four 1-inch, schedule 160 pressure nozzles, all four located on the channel head/bottom head and fabricated from SB-166 Ni-CR-FE alloy.

Steam Generator No. 2 (SG2) Instrument Pressure Tap Nozzles (4): Four 1-inch, schedule 160 pressure nozzles, all four located on the channel head/bottom head and fabricated from SB-166 Ni-CR-FE alloy.

Code Class: 1

System: Reactor Coolant System (RCS)

Code Category: B-P, All Pressure Retaining Components

Code Item Nos.:

Pressurizer:

B15.20, Pressure Retaining Boundary [System Leakage Test & Visual, VT-2 Examination Each Refueling Outage]

B15.21, Pressure Retaining Boundary [System Hydrostatic Test (System Leakage Test Per Code Case N-498-1) & Visual, VT-2 Examination One Test Per Interval]

Steam Generators:

B15.30, Pressure Retaining Boundary [System Leakage Test & Visual, VT-2 Examination Each Refueling Outage]

B15.31, Pressure Retaining Boundary [System Hydrostatic Test (System Leakage Test Per Code Case N-498-1) & Visual, VT-2 Examination One Test Per Interval]

References:

1. Pressurizer - 1968 Edition, American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section III, Class A Vessels, with Addenda through Summer 1969.

2. Steam Generators Channel Head – 1983 Edition, ASME Code, Section III, with Addenda through Summer 1984.

3. 1989 Edition, ASME Code, Section XI, No Addenda

4. 1992 Edition, ASME Code, Section III, and the 1992 Edition with the 1992 Addenda of Section II for materials.

5. 1992 Edition, ASME Code, Section XI.

2.0 CODE REQUIREMENTS:

The Construction Code of record for the Millstone Unit No. 2 pressurizer is the 1968 Edition of ASME Section III with Addenda through the Summer of 1969 (reference 1). The Construction Code of record for the steam generator channel heads is the 1983 Edition of ASME Section III with Addenda through the Summer 1984 (reference 2). Millstone Unit No. 2 is currently in its third 10-year inspection interval using the 1989 Edition of ASME Section XI (reference 3). ASME Section XI, paragraph IWA-4120 (a), states the following:

"Repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later Editions and Addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and Code Cases may be used. If repair welding cannot be performed in accordance with these requirements, the applicable alternative requirements of IWA-4500 and the following may be used: (1) IWB-4000 for Class 1 Components;"

For the repairs to the pressurizer and steam generator channel head instrumentation nozzles, paragraph N-528.2 of reference 1 and subparagraph NB-4453.5 of reference 2 respectively, requires repairs be postweld heat treated (PWHT) in accordance with paragraph N-532 for the pressurizer and NB-4620 for the steam generators. The PWHT requirements set forth therein would be difficult if not impossible to attain on a pressurizer or steam generator channel head in containment without distortion of the component. In addition, the existing instrumentation nozzle welds were not qualified with PWHT and cannot be so qualified at this time.

Consequently, the proposed repairs will be conducted in accordance with the 1989 Edition of ASME Section XI (reference 3) as applicable, the 1992 Edition of Section III (reference 4) as applicable, the 1992 Edition of Section XI (reference 5) as applicable, and alternative requirements discussed below.

3.0 CODE REQUIREMENTS FOR WHICH ALTERNATIVES ARE REQUESTED:

Dominion Nuclear Connecticut, Inc. (DNC) will be performing boric acid inspections on the pressurizer and steam generator channel heads instrumentation nozzles during the upcoming refueling outage. If any of these nozzles show evidence of leakage repair/replacement activities will be performed using a half-nozzle repair/replacement method. Per subsubarticle IWA-4120 of Section XI, repair welding must be done in accordance with the original Construction Code. Therefore, for any repair to the ferritic material of the pressurizer, paragraph N-532 of ASME Section III (reference 1), and for the steam generator channel heads, NB-4620 of ASME Section III (reference 2), PWHT would be required for the repair weld. As pointed out above, the PWHT parameters required by N-532 and NB-4620 would be difficult to achieve on a pressurizer or a steam generator channel head in containment and would pose a significant risk of distortion to the geometry of the vessel and its nozzles. Furthermore, application of PWHT to these components would expose the existing inside diameter J-groove welds to PWHT for which they were not originally qualified.

Because of the inability to comply with the requirements of the original Construction Code, the rules of ASME Section III, 1992 Edition (reference 4) will apply to the repairs. Therefore, for any pressurizer or steam generator channel head instrumentation nozzles where boric acid deposits provide evidence of leakage, the assumption will be made that flaws are present in the area of the internal J-groove weld that attaches these nozzles to the inside surface of the vessel and a repair/replacement will be performed. The repair/replacement will consist of a half-nozzle repair/replacement with a weld pad deposit made of F-No. 43 material to be welded to the vessel outside surface prior to attaching a new external J-groove partial penetration weld using a half-nozzle repair/replacement design. (See Figure 1: Typical Half-Nozzle Repair/Replacement With A Weld Pad Deposit). For this type of repair/replacement, welding to the vessel external surface, paragraph NB-4622 of Section III would require a postweld stress relief heat treatment for the repair weld or alternatively, use of the temper bead weld technique. The temper bead procedure requirements, including preheat and postweld heat soaks contained in NB-4622, would be difficult to achieve in containment, would result in a substantial increase in radiological dose and are not necessary to produce a sound repair weld given the capabilities of the proposed alternative temper bead procedure below. Therefore, pursuant to 10 CFR 50.55a(g)(4)(iv) and 10 CFR 50.55a(a)(3)(ii), DNC requests to use an ambient temperature temper bead method of welding in accordance with the requirements of the 1992 Edition of ASME Section III, NB-4622 and alternatives to these requirements contained in this request.

The requirements of paragraphs NB-4622 and NB-5244 of the 1992 Edition of ASME Section III (reference 4), and IWA-4700 and IWB-3000 of the 1989 Edition of ASME Section XI (reference 3) are also applicable to the repairs. As an alternative to these requirements, the requirements of, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," identified below will be used. Specifically, alternatives are being proposed for the following articles, subarticles, subsubarticles, paragraphs and subparagraphs of ASME Section III.

NB-4622.1 establishes the requirement for postweld heat treatment of welds including repair welds. In lieu of the requirements of this subparagraph, DNC proposes to utilize a temper bead weld procedure obviating the need for PWHT.

NB-4622.2 establishes requirements for time at temperature recording of the PWHT and their availability for review by the Inspector. The requirement of this subparagraph will 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. The subparagraph is not applicable because the proposed alternative involves no PWHT.

NB-4622.6 establishes PWHT requirements for non-pressure retaining parts. The subparagraph is not applicable in this case because the 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. Subparagraphs NB-4622.7 (a) through NB-4622.7 (f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Subparagraph NB-4622.7 (g) discusses exemptions to weld repairs to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. The ambient temperature temper bead 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. Subparagraph NB-4622.8 (a) establishes criteria for exemption of PWHT for partial penetration welds. NB-4622.8 (a)(1) is applicable to the proposed repairs because the exemption criteria involves a requirement for buttering layers at least 1/4-inch thick and is applicable to the weld pad deposit made of F-No. 43 material, which will be applied to the pressurizer or a steam generator channel head. For the new partial penetration J-groove weld between the new half-nozzle and the pad, these exemption criteria will permit not having to PWHT the new J-groove weld. The alternative provides for the remaining buttering thickness over the ferritic steel base material, after preparing the J-groove partial penetration weld preparation, to be less than 1/4-inch thick and for no PWHT of the buttering and its ferritic steel heat affected zone being performed. Subparagraph 4622.8(b) does not apply because it discusses full penetration welds and the welds in question are partial penetration welds.

NB-4622.9 establishes requirements for temper bead 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 repairs will involve application of a weld pad deposit of F-No. 43 filler metals using an automatic or machine GTAW process instead of a shielded metal arc welding (SMAW) process.

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

NB-4622.11 discusses temper bead weld repair to dissimilar metal welds or buttering and would apply to the proposed repairs/weld pad deposit.

- Subparagraph NB-4622.11 (a) requires surface examination prior to repair in accordance with NB-5000. Since the proposed alternative addresses only the weld pad deposit, ultrasonic examination in accordance with NB-5244 and a liquid penetrant examination will be performed after the final weld pad deposit. A surface examination will be performed prior to applying the pad.

- Subparagraph NB-4622.11 (b) contains requirements for the maximum extent of repair including a requirement that the depth of excavation for defect removal not exceed 3/8-inch in the base metal and the surface of the completed repair shall not exceed 100 square inches. The weld pad deposit proposed in the alternative will not require any excavation into the base metal and will be less than 100 square inches.

- Subparagraph 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 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 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 utilizes an automatic or machine applied GTAW process with bare non-consumable electrodes and bare filler wire meeting 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 non-consumable electrodes and bare filler wire that do not require storage in heated ovens since they will not absorb moisture from the environment.

  - 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 non-consumable electrodes and bare filler wire that do not require any special storage conditions to prevent their absorption of moisture from the environment.

  - NB-4622.11(c)(5) requires preheat to a minimum temperature of 350°F prior to repair welding. The proposed ambient temperature temper bead alternative does not require an elevated temperature preheat.

  - NB-4622.11(c)(6) establishes requirements for electrode diameters for the first, second, and subsequent layers of the repair welds and requires removal of the weld bead crown before deposition of the second layer. Because the proposed alternative controls the tempering process by precise control of heat input and bead placement, the 3/32, 1/8 and 5/32-inch diameter electrodes that are required by NB-4622.11(c)(6) and the requirement to remove the weld crown of the first layer are unnecessary. The proposed alternative does not include these requirements.

- NB-4622.11(c)(7) requires a hydrogen bake out be performed on the preheated area by heating to 450°F to 550°F for 4 hours after a minimum of 3/16-inch of weld metal has been deposited. The proposed alternative does not require this hydrogen bake out because the use of the extremely low hydrogen GTAW temper bead 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 limits the interpass temperature to a maximum of 350°F and requires the area to be welded be at least 50°F prior to welding. This approach has been demonstrated to be adequate for the production of sound welds with acceptable properties in both the weld and ferritic heat affected zone (HAZ).

- 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 does not require the hydrogen bake because it is unnecessary for the very low hydrogen automatic or machine applied GTAW temper bead welding process. An ultrasonic examination will be performed on the finished weld pad deposit in accordance with NB-5244 along with a liquid penetrant examination no sooner than 48 hours after the weld has cooled to ambient temperature.

- 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 examination is required if practical. The proposed alternative includes the requirement to examine after a minimum of 48 hours at ambient temperature. Because the proposed weld pad deposit configuration is not practical to radiograph and examination requirements are provided for weld buildup in NB-5244, final examination will be by the ultrasonic method coupled with an additional liquid penetrant examination.

- NB-4622.11 (d)(3) requires that all nondestructive examination be in accordance with NB-5000. The proposed alternative will comply with NB-5000 requirements except that NDE personnel qualifications will meet either IWA-2300 or NB-5000.

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

- NB-4622.11 (f) establishes requirements for the procedure qualification test plate relative to the P-No. and Group Number and the postweld heat treatment of the materials to be welded. The proposed alternative complies with these requirements, and with the additional requirements of the alternative 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 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 welds, which is particularly pertinent to the SMAW manual welding process. The proposed alternative 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. Obstructions in close proximity but not blocking the movements of the machine will have no effect on the ability of the operator or the machine to make sound welds.

- Subparagraph NB-4453.4 of Section III requires examination of the repair weld in accordance with the requirements for the original weld. The welds being made per the proposed alternative will be in the form of a weld pad deposit as described by NB-4244(c) and will meet the weld design requirements of NB-3352.4(c). For these weld pad deposits, ultrasonic examination is required in accordance with NB-5244. For the proposed alternative, the weld pad deposit will be examined by an ultrasonic method in accordance with NB-5244 and with a liquid penetrant examination. These examinations will be performed no sooner than 48 hours after the weld pad has cooled to ambient temperature.

- Subarticle IWA-4700 of ASME Section XI 1989 Edition (reference 2), requires a system hydrostatic test in accordance with IWA-5000 for welded repairs to the pressure retaining boundary. As discussed in more detail in Section 4.0 BASIS FOR THE REQUESTED ALTERNATIVES, item 4.8 below, the proposed alternative will utilize a system leakage test per IWA-5211 (a) of ASME Section XI 1992 Edition (reference 5) in accordance with Code Case N-416-1 in lieu of the system hydrostatic test.

4.0 BASIS FOR THE REQUESTED ALTERNATIVES:

The alternative to NB-4622 requirements being proposed involve the use of an ambient temperature temper bead 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 enumerated below:

4.1. The proposed alternative will require the use of an automatic or machine GTAW temper bead 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, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique." The alternative will be used to make a weld pad deposit to P-No. 3, Group No. 3, pressurizer base material A-533, Gr. B Class 1 or steam generator channel head base material SA-508 CL3 with F-No. 43, Alloy 52 weld filler material.

4.2. The use of an automatic or machine GTAW temper bead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by EPRI and other organizations. (Reference, EPRI Report GC-111050, "Ambient Temperature Preheat for Machine GTAW Temper Bead Applications," dated November 1998.) The research demonstrates that carefully controlled heat input and bead placement allow subsequent welding passes to relieve stress and temper the heat affected zones 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 post-heats, as well as with no preheat and post-heat. From that data, it is clear that equivalent toughness is achieved in base metal and heat affected zones in both cases. The temper bead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed. Many acceptable Procedure Qualification Records (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 temper bead welding allows more precise control of heat input, bead placement, and bead size and contour than the manual SMAW process required by NB-4622. The very precise control over these factors afforded by the alternative provides more consistent and effective tempering and eliminates the need to grind or machine the first layer of the repair.

4.3. The NB-4622 temper bead procedure requires a 350°F preheat and a postweld soak at 450° to 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 monatomic hydrogen in ferritic materials prone to hydrogen embrittlement cracking. The susceptibility of ferritic steels is directly related to three factors: 1) the propensity of the material to transform to a crack susceptible microstructure; 2) the level of monatomic hydrogen present; and 3) the level of tensile stress. The P-No. 3 material of the pressurizer or a steam generator channel head is able to produce martensite from the heating and cooling cycles associated with welding. However, the proposed alternative mitigates all three factors without the use of elevated preheat and postweld hydrogen bake out by closely controlling the welding heat input, bead placement and minimizing the introduction of hydrogen in the welding process.

The NB-4622 temper bead procedure requires the use of the SMAW welding process with covered electrodes. The low hydrogen electrodes, which are required by NB-4622, are a source of hydrogen even when very stringent electrode baking and storage procedures are followed. Even ultra low hydrogen (H4) SMAW electrodes can introduce up to 4 ml of monatomic hydrogen (H) per 100 grams of deposited weld metal. 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 temper bead procedures require preheat and postweld hydrogen bake-out. However, the proposed alternative temper bead procedure utilizes an automatic or machine GTAW process, which is essentially free of hydrogen. The GTAW process relies on bare welding non-consumable electrodes and bare filler wire with no flux to trap moisture. An inert gas blanket positively shields the weld and surrounding material from the atmosphere and moisture it may contain. It produces by far the lowest hydrogen levels of any of the commonly used arc welding processes. Typically, deposits are less than 1mL per 100 grams of deposited weld metal. To further reduce the likelihood of any hydrogen evolution or absorption, the alternative procedure requires particular care to ensure the weld region is free of all sources of hydrogen. The automatic or machine GTAW process will be shielded with welding grade argon (99.997% pure), which typically produces welds essentially free of hydrogen. A typical argon flow rate would be about 15 to 50 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.

4.4. The weld pad deposits used for the repair/replacements will not be subject to hydrogen embrittlement cracking due to the controlled nature of the automatic or machine GTAW process and the use of the F-No. 43 (ERNiCrFe-7) filler metal with the temper bead technique that has been described above.

4.5. Final examination of the repair welds, that is the weld pad deposits, would consist of an ultrasonic examination in accordance with NB-5244 and a liquid penetrant examination. These examinations will be performed no sooner than 48 hours after the weld pad has cooled to ambient temperature and before final welding and machining of the new half-nozzle repair/replacement weld. The 48-hour delay before final examination would provide ample time for any hydrogen that may 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 not susceptible to hydrogen embrittlement cracking. Thus, any hydrogen-induced cracking will have occurred by the time the final LP and UT is conducted. In the unlikely event that hydrogen-induced cracking did occur within this 48-hour delay while hydrogen was still present, it would be detected by the 48-hour delayed UT and PT examinations.

4.6. Results of procedure qualification work undertaken to date indicate that the process produces sound and tough welds. Typical tensile test results have been ductile breaks in the weld metal and the base metal.

As shown below, Procedure Qualification Record (FRA-ANP PQR 7164) using P-No. 3, Group No. 3 base material exhibited improved Charpy V-notch properties in the HAZ from all three measures. Absorbed energy, lateral expansion and % shear area were improved, compared to the unaffected base material.

PQR 7164	Unaffected Base Material	(avg)	HAZ	(avg)
50°F absorbed energy (ft-lbs.)	69, 55, 77	(67)	109, 98, 141	(116)
50°F lateral expansion (mils)	50, 39, 51	(47)	59, 50, 56	(55)
50°F shear fracture (%)	30, 25, 30	(28)	40, 40, 65	(48)
80°F absorbed energy (ft-lbs.)	78, 83, 89	(83)	189, 165, 127	(160)
80°F lateral expansion (mils)	55, 55, 63	(58)	75, 69, 60	(68)
80°F shear fracture (%)	35, 35, 55	(42)	100, 90, 80	(90)

The absorbed energy, lateral expansion, and percent shear fracture were significantly greater for the HAZ than the unaffected base material at both test temperatures.

4.7. Welding procedure qualification fully supports the welding procedure specification (WPS). The welding procedure qualification supporting the applicable WPS to be used for the repair weld/weld pad deposit is for P-No. 3 Group No. 3 base material welded with F-No. 43 filler metal. Using the WPS, the proposed alternative (Enclosure 1) provides a technique for applying a weld deposited pad to the external surface of the pressurizer or a steam generator channel head that will produce sound, permanent repair/replacements with an acceptable level of quality and safety.

4.8. IWA-4700 requires a system hydrostatic test in accordance with IWA-5000 for welded repairs to the pressure-retaining boundary. In lieu of a system hydrostatic test, which must be conducted at pressures exceeding normal operating pressure, the proposed alternative relies on a system leak test in accordance with the 1992 Edition of Section XI, IWA-5211 (a) to be performed at nominal operating pressure and nominal operating temperature coupled with nondestructive examination of the proposed weld pad deposit that offers an equivalent or higher confidence of the soundness of the weld. As discussed previously, the weld pad deposit will be ultrasonically examined in accordance with NB-5244 and with a liquid penetrant examination method prior to final machining and welding of the new half-nozzle repair/replacement weld. These examinations will be performed no sooner than 48 hours after the weld pad has cooled to ambient temperature and these examinations will provide added assurance of sound welds when done in conjunction with the planned system leak test. Since the proposed system leakage test requirements are similar to the provisions of approved ASME Code Case N-416-1[1] it is concluded that the proposed alternative provides an acceptable level of quality and safety.

4.9. To produce sound welds, control of the welding process is essential. The welding head that will be used for the weld pad deposits that will be made with the alternatives provided in this request has video capability for torch positioning and monitoring during welding. The operator observes the welding operation as well as observing each bead deposited prior to welding the next bead. The video clarity and resolution is such that the welding operator can observe a 1/2 mil diameter color contrast wire and thus this point concludes the basis for the alternative requirements in this request.

5.0 ALTERNATIVE REQUIREMENTS:

Repair/replacements that include the weld pad deposits needed to support the half-nozzle repair/replacements, that are planned for the pressurizer or steam generator channel head instrumentation nozzles at the specific location of the new weld pads will be made in accordance with the requirements of subsubarticles IWA-4110, 4120, 4130, 4140, 4210, 4330, 4340, and subarticles 4400, 4600 and 4800 of the 1989 Edition of ASME Section XI with the alternative requirements identified below.

The requirements of paragraphs NB-4622 and NB-5244 of the 1992 Edition of ASME Section III (reference 4), and IWA-4700 and IWB-3000 of the 1989 Edition of ASME Section XI (reference 3) are also applicable to the contemplated repairs. As an alternative to these requirements, the requirements of, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," (Enclosure 1) will be used. Specifically, alternatives are being proposed for the following articles, subarticles, subsubarticles, paragraphs and subparagraphs of ASME Section III and Section XI.

NB-4622.1 establishes the requirement for postweld heat treatment of welds including repair welds. In lieu of the requirements of this subparagraph, DNC proposes to utilize a temper bead weld procedure obviating the need for PWHT.

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

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[1] Approval To Use Code Case N-416-1, NRC letter, "Evaluation of the Third 10-Year Interval Inservice Inspection Program Plan and Associated Requests for Relief for Millstone Nuclear Power Station, Unit No. 2, (TAC No. M96200)," dated July 22, 1998.

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 non-pressure retaining parts. The subparagraph is not applicable in this case because the 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. Subparagraphs NB-4622.7 (a) through NB-4622.7 (f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Subparagraph NB-4622.7 (g) discusses exemptions to weld repairs to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. The ambient temperature temper bead 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 connections to run piping welds. Subparagraph NB-4622.8 (a) establishes criteria for exemption of PWHT for partial penetration welds. NB-4622.8 (a)(1) is applicable to the proposed repairs because the exemption criteria involves a requirement for buttering layers at least 1/4 inch thick and is applicable to the weld pad deposit made of F-No. 43 material, which will be applied to the pressurizer or a steam generator channel head, and then for the new partial penetration J-groove weld between the new half-nozzle and the pad. These exemption criteria will permit not having to PWHT the new J-groove weld. The alternative provides for the remaining buttering thickness over the ferritic steel base material, after preparing the J-groove partial penetration weld preparation, to be less than 1/4-inch thick and for no PWHT of the buttering and its ferritic steel heat affected zone being performed. Subparagraph 4622.8(b) does not apply because it discusses full penetration welds and the welds in question are partial penetration welds.

NB-4622.9 establishes requirements for temper bead 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 repairs will involve application of a weld pad deposit of F-No. 43 filler metals using an automatic or machine GTAW process instead of a shielded metal arc welding (SMAW) process.

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

NB-4622.11 discusses temper bead weld repair to dissimilar metal welds or buttering and would apply to the proposed repairs/weld pad deposits as follows:

- Subparagraph NB-4622.11 (a) requires surface examination prior to repair in accordance with NB-5000. Since the proposed alternative addresses only the weld pad deposit, ultrasonic examination in accordance with NB-5244 and a liquid penetrant examination will be performed after the final weld pad deposit. A surface examination will be performed prior to applying the pad.

- Subparagraph NB-4622.11 (b) contains requirements for the maximum extent of repair including a requirement that the depth of excavation for defect removal not exceed 3/8-inch in the base metal and the surface of the completed repair shall not exceed 100 square inches. The weld pad deposit proposed in the alternative will not require any excavation into the base metal and will be less than 100 square inches.

- Subparagraph 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 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 will satisfy this requirement.

    - NB-4622.11(c)(2) requires the use of the SMAW process with covered electrodes meeting either the A-No. 8 or F-No. 43 classifications. The proposed alternative utilizes an automatic or machine applied GTAW with bare non-consumable electrodes and bare filler wire meeting the F-No. 43 classification.

    - 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 non-consumable electrodes and bare filler wire that do not require storage in heated ovens since they will not absorb moisture from the environment.

    - 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 non-consumable electrodes and bare filler wire that do not require any special storage conditions to prevent their absorption of moisture from the environment.

- NB-4622.11(c)(5) requires preheat to a minimum temperature of 350°F prior to repair welding. The proposed ambient temperature temper bead alternative does not require an elevated temperature preheat.

- NB-4622.11(c)(6) establishes requirements for electrode diameters for the first, second, and subsequent layers of the repair welds and requires removal of the weld bead crown before deposition of the second layer. Because the proposed alternative controls the tempering process by precise control of heat input and bead placement, the 3/32, 1/8 and 5/32-inch diameter electrodes that are required by NB-4622.11(c)(6) and the requirement to remove the weld crown of the first layer are unnecessary. The proposed alternative does not include these requirements.

- NB-4622.11(c)(7) requires a hydrogen bake out be performed on the preheated area by heating to 450°F to 550°F for 4 hours after a minimum of 3/16-inch of weld metal has been deposited. The proposed alternative does not require this hydrogen bake out because the use of the extremely low hydrogen GTAW temper bead 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 limits the interpass temperature to a maximum of 350°F and requires the area to be welded be at least 50°F prior to welding. This approach has been demonstrated to be adequate for the production of sound welds with acceptable properties in both the weld and ferritic HAZ.

- 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 does not require the hydrogen bake because it is unnecessary for the very low hydrogen automatic or machine applied GTAW temper bead welding process. An ultrasonic examination will be performed on the finished weld pad deposit in accordance with NB-5244 along with a liquid penetrant examination no sooner than 48 hours after the weld has cooled to ambient temperature.

- 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 examination is required if practical. The proposed alternative includes the requirement to examine after a minimum of 48 hours at ambient temperature. Because the proposed weld pad deposit configuration is not practical to radiograph and examination requirements are provided for weld buildup in NB-5244, final examination will be by the ultrasonic method coupled with an additional liquid penetrant examination.

➢ NB-4622.11 (d)(3) requires that all nondestructive examination be in accordance with NB-5000. The proposed alternative will comply with NB-5000 requirements except that NDE personnel qualifications will meet either IWA-2300 or NB-5000.

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

- NB-4622.11 (f) establishes requirements for the procedure qualification test plate relative to the P-No. and Group Number and the postweld heat treatment of the materials to be welded. The proposed alternative complies with those requirements, and with the additional requirements of this alternative 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 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 welds, which is pertinent to the SMAW manual welding process. The proposed alternative 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. Obstructions in close proximity but not blocking the movements of the machine will have no effect on the ability of the operator or the machine to make sound welds.

- Subparagraph NB-4453.4 of Section III requires examination of the repair weld in accordance with the requirements for the original weld. The welds being made per the proposed alternative will be in the form of a weld pad deposit as described by NB-4244(c) and will meet the weld design requirements of NB-3352.4(c). For these weld pad deposits, ultrasonic examination is required in accordance with NB-5244. For the proposed alternative, the weld pad deposit will be examined by an ultrasonic method in accordance with NB-5244 and with a liquid penetrant examination. These examinations will be performed no sooner than 48 hours after the weld pad has cooled to ambient temperature.

- Subarticle IWA-4700 of ASME Section XI, 1989 Edition (reference 3), requires a system hydrostatic test in accordance with IWA-5000 for welded repairs to the pressure-retaining boundary. As discussed in Section 4.0, BASIS FOR THE REQUESTED ALTERNATIVES, item 4.8, the proposed alternative will utilize a system leakage test per IWA-5211 (a) of ASME Section XI, 1992 Edition (reference 5) in accordance with Code Case N-416-1 in lieu of the system hydrostatic test.

Per the 1989 Edition of ASME Section XI, paragraph IWB-2200 (a), no preservice examination is required for weld pad deposits or instrumentation nozzles on the pressurizer or a steam generator head, which are included under (Examination Category B-P). 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 Visual, VT-2 examination during a system leakage test that is conducted each refueling outage and the system hydrostatic test performed each 10-year interval. Currently both of these examinations are being covered under Code Case N-498-1. Additionally, bare metal boric acid inspections are performed each refueling outage for 100% of the pressurizer and steam generator channel head instrumentation nozzles that are the subject of this alternative request.

Based on the above information, DNC has concluded that the requirements currently contained in the ASME Code Sections III and XI, which are described in this alternative request, will result in a hardship and unusual difficulty without a compensating increase in the level of quality or safety. Therefore, use of the proposed alternative ambient temperature temper bead weld technique (Enclosure 1) is an acceptable alternative in accordance with 10 CFR 50.55a(a)(3)(ii).

6.0 DURATION OF THE PROPOSED ALTERNATIVE:

The alternative in this request will be applied for the remainder of the current third 10-year ISI interval, which started on April 1, 1999. Once a weld pad deposit is applied to the pressurizer or a steam generator channel head as part of a half-nozzle repair/replacement activity, the weld pad deposit will remain in place for the life of the plant, including any license renewal period. The proposed alternative of this request will be applicable to any future replacement of Alloy 600 small bore nozzles on the pressurizer or the steam generator channel heads.

7.0 PRECEDENTS:

A similar request for the use of an alternative to temper bead welding requirements for pressurizer heater sleeve weld deposited pads was submitted by Palo Verde Nuclear Generating Station, Units 1, 2, and 3 and was approved by the NRC on July 30, 2003 under (TAC NOS. MB8973, MB8974 and MB8975) and Docket Nos. STN 50-528, STN 50-529, and STN 50530. Additionally, DNC has provided a similar request to allow the use of the automatic or machine GTAW alternative temper bead welding requirements for reactor vessel head penetration nozzle repairs that was approved by the NRC on October 2, 2002 under (TAC NO.MB4223) and Docket No. 50-336.

ENCLOSURE 1

Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique

Dominion Nuclear Connecticut, Inc. (DNC) plans to perform, as needed, weld pad deposits on the pressurizer or steam generator channel head instrumentation nozzles as part of a half-nozzle repair/replacement activity by welding to the pressurizer or steam generator channel head base material (P-No. 3 base material) with weld filler material F-No. 43, in accordance with the following:

1.0 GENERAL REQUIREMENTS:

a. The maximum area of the weld pad deposit on the finished surface will be less than 100 square inches, and the depth of the weld will not be greater than one-half of the ferritic base metal thickness.

b. Repair/replacement activities on a dissimilar-metal weld 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 provided the depth of repair in the base material does not exceed 3/8 inch.

d. Prior to welding, the area to be welded and a band around the area of at least 1-1/2 times the component thickness or 5-inches, whichever is less, will be at least 50°F.

e. Welding materials will meet the Owner's Requirements and the Construction Code and will be reconciled to meet at least the 1992 Edition of Section III with the 1992 Addenda (reference 4) and any Cases specified in the repair/replacement plan. Welding materials will be controlled so that they are identified as acceptable until consumed.

f. Peening will not be used.

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 will be P-No. 3 and Group No. 3, which is the same P-No. and Group No. as the low alloy steel pressurizer or steam generator channel head material to be welded. The base material will be postweld heat treated to at least the time and temperature that was applied to the materials being welded.

b. The root width and included angle of the cavity in the test assembly will be no greater than the minimum specified for the repair.

c. The maximum interpass temperature for the first three layers of the test assembly will be 150°F.

d. The ferritic steel P-No. 3 Group No. 3 base material test assembly cavity depth will 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 will be at least twice the test assembly cavity depth. The test assembly will be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity will be at least the test assembly thickness, and at least 6-inches. The qualification test plate will be prepared in accordance with Figure 2.

e. Ferritic base material for the procedure qualification test will meet the impact test requirements of the Construction Code and Owner's Requirements.

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

   (1) The specimens will be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The test coupons for HAZ impact specimens will be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimens will 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 will 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 will be oriented parallel to the principal direction of rolling or forging.

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

g. The average values of the three HAZ impact tests will be equal to or greater than the average values of the three unaffected base metal tests.

2.2 Performance Qualification

Welding operators will be qualified in accordance with ASME Section IX.

3.0 WELDING PROCEDURE REQUIREMENTS:

The welding procedure shall include the following requirements:

a. The weld metal will be deposited by the automatic or machine GTAW process.

b. Dissimilar metal weld pad deposits shall be made using F-No. 43 ER NiCrFe-7 weld filler metal to P-No. 3 base metal.

c. The ferritic steel area to be welded will be buttered with a deposit of at least three layers to achieve at least 1/8-inch overlay thickness as shown in Figure 3, 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 will be taken in placement of the weld layers at the weld toe area of the ferritic material to ensure that the HAZ is tempered. Subsequent layers will be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification.

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

4.0 EXAMINATION:

a. The final weld pad deposit surface and adjacent HAZ will be examined using the liquid penetrant and ultrasonic methods to the extent specified in Section 1.0, item d, when the completed weld has been at ambient temperature for at least 48 hours.

b. Ultrasonic testing (UT) will be performed that scans from the outside surface of the pressurizer or a steam generator channel head. UT coverage will include the weld pad deposit/weld metal buildup, the fusion zone, and the parent metal beneath the weld metal buildup to ensure freedom from lack of fusion and laminar defects per NB-5244.

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

d. NDE personnel will be qualified in accordance with either NB-5000 of reference 4 or IWA-2300 of reference 5.

e. Surface examination acceptance criteria will be in accordance with NB-5340 or NB-5350, as applicable. Ultrasonic examination acceptance criteria will be in accordance with NB-5330.

5.0 DOCUMENTATION:

Use of this alternative will be documented on a Form NIS-2 or NIS-2A.

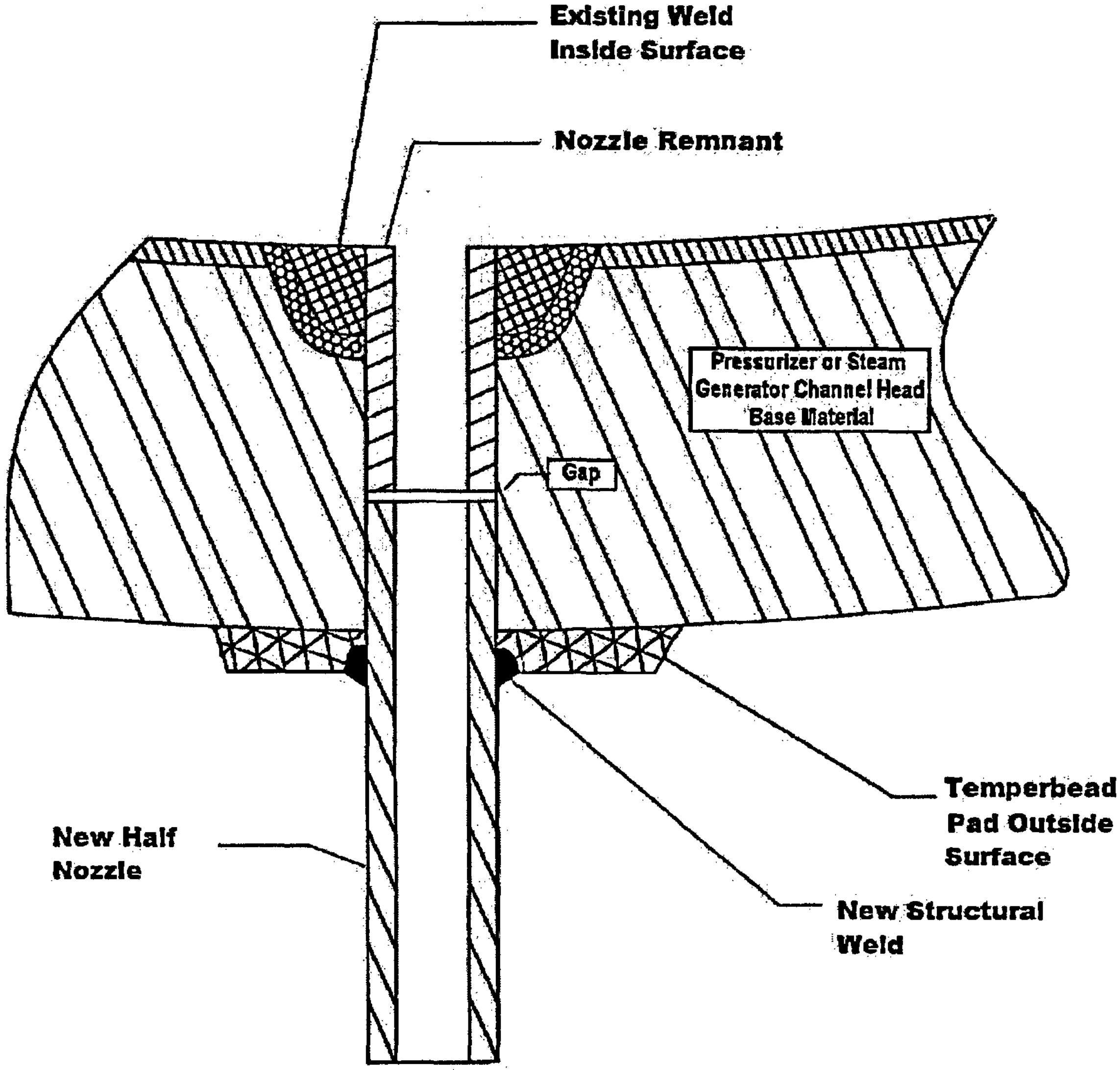
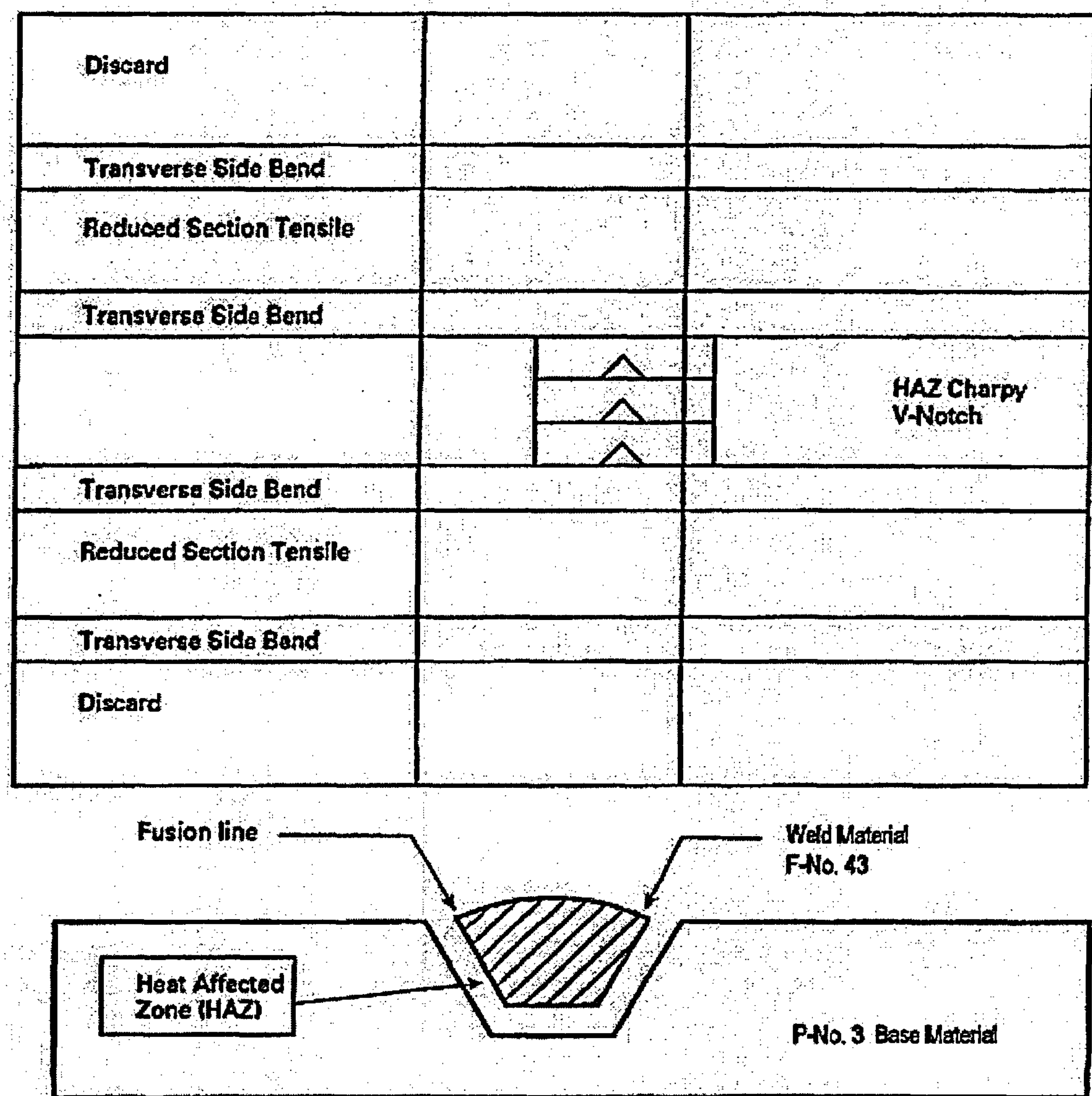
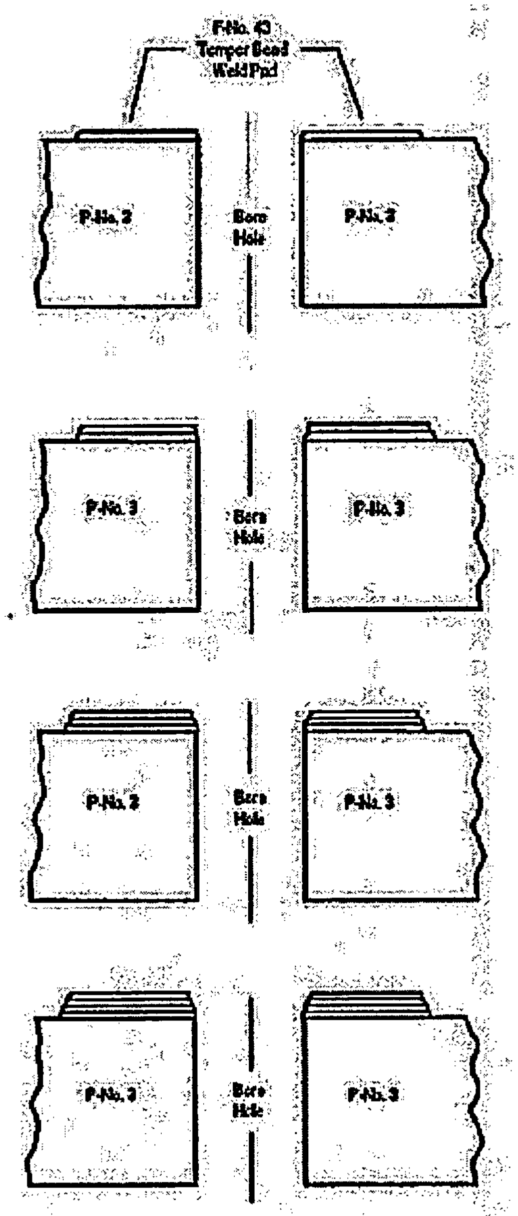


FIGURE 1:
TYPICAL HALF-NOZZLE REPAIR/REPLACEMENT WITH
A WELD PAD DEPOSIT



GENERAL NOTE: Base metal Charpy impact specimens are not shown. This figure illustrates a Dissimilar Metal Weld.

FIGURE 2: 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 dissimilar metal welding using a F-No. 43 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.

FIGURE 3: AUTOMATIC OR MACHINE (GTAW) TEMPER BEAD WELDING

Attachment 2

Millstone Power Station, Unit No. 2

Request RR-89-45, Use of Alternative Acceptance Standards Requirements
Without Flaw Removal in Alloy 600 Small Bore Nozzles

Request RR-89-45, Use of Alternative Acceptance Standards Requirements Without Flaw Removal in Alloy 600 Small Bore Nozzles

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Request RR-89-45, Use of Alternative Acceptance Standards Requirements
Without Flaw Removal in Alloy 600 Small Bore Nozzles

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(ii)

- Hardship or Unusual Difficulty without Compensating
Increase in Level of Quality or Safety -

1.0 COMPONENT IDENTIFICATION

Pressurizer Instrumentation Nozzles (8):

Level Nozzles (4): Four 1-inch, schedule 160 level nozzles, two in the upper head and two in the lower head, all fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Pressure Nozzles (2): Two 1-inch, schedule 160 pressure nozzles in the upper head, all fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Temperature Nozzles (2): Two 1-inch, schedule 160 temperature nozzles, one in the top head (steam space) and one in the lower shell (heater area), both fabricated from SB-166 Ni-Cr-Fe alloy with SA-182 (F-316) stainless steel socket weld safe ends.

Steam Generator Instrumentation Nozzles (8):

Steam Generator No. 1 (SG1) Instrument Pressure Tap Nozzles (4): Four 1-inch, schedule 160 pressure nozzles, all four located on the channel head/bottom head and fabricated from SB-166 Ni-CR-FE alloy.

Steam Generator No. 2 (SG2) Instrument Pressure Tap Nozzles (4): Four 1-inch, schedule 160 pressure nozzles, all four located on the channel head/bottom head and fabricated from SB-166 Ni-CR-FE alloy.

Reactor Coolant System (RCS) Piping Instrumentation Nozzles (31):

Loop 1 Hot Leg Instrument Nozzles (10): Five 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy and Five 3/4-inch schedule 160 pressure measurement or sampling nozzles, all fabricated from B-166 Ni-Cr-Fe alloy with a A-182, type 316 stainless steel safe end.

Loop 1 Cold Leg Pump 1A to RPV Instrument Nozzles (3): Three 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy.

Loop 1 Cold Leg Pump 1B to RPV Instrument Nozzles (3): Three 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy.

Loop 2 Hot Leg Instrument Nozzles (9): Five 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy and Four 3/4-inch schedule 160 pressure measurement or sampling nozzles, all fabricated from B-166 Ni-Cr-Fe alloy with a A-182, type 316 stainless steel safe end.

Loop 2 Cold Leg Pump 2A to RPV Instrument Nozzles (3): Three 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy.

Loop 2 Cold Leg Pump 2B to RPV Instrument Nozzles (3): Three 1-inch nominal diameter temperature measurement (RTD) nozzles, B-166 Ni-Cr-Fe alloy.

Code Class: 1

System: Reactor Coolant System (RCS)

Code Category: B-P, All Pressure Retaining Components

Code Item Nos.:

Pressurizer:

B15.20, Pressure Retaining Boundary [System Leakage Test & Visual, VT-2 Examination Each Refueling Outage]

B15.21, Pressure Retaining Boundary [System Hydrostatic Test (System Leakage Test Per Code Case N-498-1) & Visual, VT-2 Examination One Test Per Interval]

Steam Generators:

B15.30, Pressure Retaining Boundary [System Leakage Test & Visual, VT-2 Examination Each Refueling Outage]

B15.31, Pressure Retaining Boundary [System Hydrostatic Test (System Leakage Test Per Code Case N-498-1) & Visual, VT-2 Examination One Test Per Interval]

RCS Piping

B15.50, Pressure Retaining Boundary [System Leakage Test & Visual, VT-2 Examination Each Refueling Outage]

B15.51, Pressure Retaining Boundary [System Hydrostatic Test (System Leakage Test Per Code Case N-498-1) & Visual, VT-2 Examination One Test Per Interval]

References:

1. 1989 Edition, American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, No Addenda.

2. 1992 Edition, ASME Code, Section XI.

3. Pressurizer - 1968 Edition, ASME Code, Section III, Class A Vessels, with Addenda through Summer 1969.

4. Steam Generators Channel Head – 1983 Edition, ASME Code, Section III, with Addenda through Summer 1984.

5. RCS Piping – ANSI B 31.7 – 1968 Edition, Class 1, and design also satisfies the requirements of ASME, Code Section III 1968 Edition with the Summer 1969 Addenda.

6. 1992 Edition, ASME Code, *Section III, and the 1992 Edition with the* 1992 Addenda of Section II for materials.

7. WCAP-15973-P, Rev 00 (CE NPSD-1198-P, Revision 01), "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," Westinghouse Proprietary Class 2, Dated: November 2002.

2.0 CODE REQUIREMENTS:

The 1989 Edition of ASME Section XI, No Addenda (reference 1) is the current ASME Code used for the Inservice Inspection (ISI) program and for Repair and Replacement program activities at Millstone Unit No. 2. The ASME Code ISI requirements for the instrumentation nozzles of the pressurizer, the steam generator channel heads, and the RCS piping, are described above and are performed in accordance with Table IWB-2500-1, "Examination Category B-P, a Visual, VT-2 examination during a system leakage test that is conducted each refueling outage and the system hydrostatic test performed each 10-year interval. Currently, both of these examinations are being covered under Code Case N-498-1 and in accordance with the Code Case a system leakage test is performed in lieu of the system hydrostatic test. Acceptance Standards of IWB-3000 and repair/replacement activities of IWA-4000 and IWA-7000 apply with the exemptions under IWA-4700 and IWA-7400. Subarticle IWA-4700 requires a system hydrostatic test in accordance with IWA-5000 for welded repairs to the pressure-retaining boundary, but exempts "component connections, piping, and associated valves that are NPS 1 and smaller" under IWA-4700(c), and this exemption also applies when using Code Case N-416-1. Consistent with these exemptions, DNC will perform a bare metal VT-2, type visual examination during a system leakage test per IWA-5211 (a) of ASME Section XI, 1992 Edition (reference 2). This bare metal visual examination will be performed at nominal operating pressure and nominal operating temperature during plant start-up for any half-nozzle repair/replacement that is installed.

The Construction Code of record for the pressurizer is the 1968 Edition of ASME Section III with Addenda through the Summer of 1969 (reference 3). The Construction Code of record for the steam generator channel heads is the 1983 Edition of ASME Section III with Addenda through the Summer 1984 (reference 4). RCS piping is ANSI B31.7 – 1968 Edition, Class 1, and the design also satisfies the requirements of ASME Code Section III 1968 Edition with the Summer 1969 Addenda (reference 5).

3.0 CODE REQUIREMENTS FOR WHICH ALTERNATIVES ARE REQUESTED:

Pursuant to 10 CFR 50.55a(a)(3)(ii), Dominion Nuclear Connecticut, Inc. (DNC) requests an alternative to the requirements of ASME Section XI, 1989 Edition, No Addenda, paragraph IWB-3142.5 "Acceptance by Replacement" that states the following:

> *"As an alternative to either the supplemental examinations of IWB-3142.2, the corrective measures or repairs of IWB-3142.3, or the evaluation of IWB-3142.4, the component or that part of the component containing the relevant condition shall be replaced."*

Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

4.0 REASON FOR THE REQUEST:

Millstone Unit No. 2 is an older vintage 2 Loop Combustion Engineering (CE) Pressurized Water Reactor (PWR) plant that went into commercial operation December 26, 1975 and whose construction permit was issued on December 11, 1970. The Class 1 components were all designed to earlier Construction Codes as outlined above. Specifically, the instrumentation nozzles of the pressurizer, the steam generator channel heads, and the RCS piping are J-groove partial penetration welds to the interior of the components. See Figures 1 and 2 for a typical configuration of an existing J-groove weld in each component. The materials of these small bore National Pipe Schedule (NPS) 1-inch and less instrumentation nozzles include Alloy 600 pipe or tube, which were J-groove welded to the carbon or low alloy steel base material of the subject components.

Industry experience has shown that cracks may develop in the nozzle pipe or tube material or in the weld metal joining the nozzles to the pressurizer or RCS hot leg piping and may lead to reactor coolant leakage. The cracks are believed to be caused by primary water stress corrosion cracking (PWSCC). Until just recently, cracking was not thought to occur in other than the pressurizer or RCS hot leg piping, but with the cracking of the reactor pressure vessel lower head instrumentation nozzles at South Texas Unit 1 and the issuance of NRC Bulletin 2003-02 "Leakage from Reactor Pressure Vessel Lower Head Penetrations and Reactor Coolant Pressure Boundary Integrity," dated August 2, 2003, industry experience has been broadened to indicate that this cracking may occur anywhere in the reactor coolant pressure boundary where these types of instrumentation nozzles (Alloy 600) exist.

Because of this industry experience, DNC will perform bare metal visual examinations on instrumentation nozzles of susceptible components in the reactor coolant pressure boundary during the upcoming refueling outage (RFO15). The examination that will be performed is a visual examination of the bare metal nozzle and the surrounding outside surface of the nozzles on the pressurizer, the steam generator channel heads, and the RCS piping. Even if the results of these examinations reveal relevant conditions such as evidence of leakage by the discovery of boric acid, the exact leak path through the weld or through the nozzle tube or pipe base material or both cannot be determined without accessing the internal surface of the components. To remove all possible leak paths by replacing the nozzle (i.e., grinding out the J-groove weld and replacing the tube or pipe) or accepting the as-found condition by performing any type of actual flaw/relevant condition characterization using NDE to establish acceptability will require accessing the internal surface of the components. Any of these activities will result in high radiation exposure to personnel involved, exposing personnel to safety hazards associated with grinding and welding in an extremely limited environment and draining the component for the full duration of the repair/replacement activity.

5.0 ALTERNATIVE REQUIREMENTS:

If visual examinations determine that an instrumentation nozzle is leaking, a half-nozzle repair will be performed to the requirements of the ASME Section XI Repair and Replacement Program. The typical design of these repairs will be as shown in Figure 1 for both the pressurizer and steam generator channel head nozzles and in Figure 2 for the RCS piping nozzles. As part of this alternative request, approval is also requested under 10 CFR 50.55a(g)(4)(iv) to use a later Edition of the Construction Code, the 1992 Edition, ASME Code, Section III, and the 1992 Edition with the 1992 Addenda of Section II for materials (reference 6) to perform this repair/replacement. Use of this later Edition of Section III will be reconciled with the Construction Code requirements for the instrumentation nozzles of the pressurizer, the steam generator channel heads, and the RCS piping depending on the need to perform a half-nozzle repair. Additionally, the applicable design report or stress analysis report will be updated as needed for the repair/replacement activity of the components affected. If the need arises to perform a half-nozzle repair to any of the components discussed above, this repair will be considered to be a permanent replacement and thus will serve as an alternative to meeting the "Acceptance by Replacement" requirements of IWB-3142.5 without having to replace the component (the instrumentation nozzle) or portion of the component (the existing nozzle and internal J-groove weld) that is assumed to contain the relevant condition (the flaw that caused the leakage).

In the half-nozzle repair/replacement, the existing tube, pipe, or nozzle is cut off at the outside surface of the pressurizer wall, the steam generator channel head wall, or the RCS pipe wall. Then a portion of the existing nozzle is machined away leaving a section of the nozzle in place along with the internal J-groove weld. The removed portion of the Alloy 600 existing nozzle is replaced with a short section (half-nozzle) of new Alloy 690 material which is J-groove welded to the outside surface of a weld pad deposit on the pressurizer or on the steam generator channel head, or directly to the outside surface of the RCS pipe. A progressive liquid penetrant examination is then performed in accordance with NB-5245 for intermediate and final weld acceptance. Once welding is completed a small gap will exist between the inner end of the new nozzle section and the outer end of the existing portion of the Alloy 600 nozzle and the existing J-groove partial penetration weld on the internal surface, that remain in place. Because this portion of the existing nozzle design remains in place it is assumed that the flaw(s), that caused the leakage, will also remain in place. An individual analysis will be performed for the pressurizer, the steam generator channel head, RCS hot leg piping, and RCS cold leg piping where a half-nozzle repair/replacement is installed in lieu of fully characterizing the flaw(s). This analysis will utilize the worst-case assumptions to conservatively bound the flaw extent and orientation. Additionally, a flaw growth and fracture mechanics evaluation of the assumed flaw configuration will also be performed to provide reasonable assurance of maintaining the individual components structural integrity. The analysis will be performed to meet the requirements of IWB-3600 of the ASME Code, Section XI, 1989 Edition, no Addenda (reference 1), and will be submitted for approval prior to resumption of continued operations.

6.0 BASIS FOR THE REQUESTED ALTERNATIVES:

6.1 Structural Integrity

A plant specific evaluation will be completed for each of the components where a half-nozzle repair/replacement is installed. This evaluation will be performed because utilizing a half-nozzle repair/replacement will leave flaws in the original weldments or associated base material of the nozzle remnants that could potentially grow into the adjacent component ferritic material. Postulated flaws will be assessed for flaw growth and flaw stability as specified in the 1989 Edition, ASME Code, Section XI, no Addenda (reference 1), and the results will demonstrate compliance with these requirements. The reconfigured penetration weld will be qualified in accordance with 1992 Edition, ASME Code Section III (reference 6). The following paragraphs describe the analysis to be performed.

In brief, design qualification and structural integrity are demonstrated in accordance with ASME Section III with evaluation of unrepaired flaws in accordance with ASME Section XI. Fatigue analysis for unflawed portions of the pressure boundary is conducted in accordance with ASME Section III, and considers the anticipated remaining life of the plant, which includes the license renewal period. The analysis methodology is similar for all instrument locations.

The change to the pressure boundary involves replacing a J-groove partial penetration weld on the inside surface of the piping or vessel with a similar weld on the outside surface. On the vessels only, a temper bead welded pad serves as an intermediate material between the original component ferritic low alloy steel material and the new weld. The original weld is assumed to contain a PWSCC induced crack that could start to grow into the carbon or low alloy steel base material by fatigue crack growth. Also a portion of the base metal in the penetration bore is exposed to the PWR environment and could lose material by corrosion wastage, however the gross wall loss is negligible so only the effect on fatigue is explicitly considered. The key locations to qualify under Code requirements are thus the area of the new J-weld and the structural stability of the assumed crack extending from the original J-weld into the vessel or piping wall.

The loading conditions for fatigue analysis include all plant conditions and transients as identified in the latest revision of the appropriate Design Specification with extended cycles representing continued operation through the period of license renewal. The full set of transients is conservatively bounded by a binned set of equivalent transients, however the total cycles and the maximum transient severity is not reduced.

The replacement weld configuration is analytically modeled using standard finite element analysis techniques for both the thermal and structural evaluation. This facilitates the evaluation of the configuration and provides stresses to demonstrate conformance with the requirements of ASME III NB-3200 limits on stress levels and the cumulative fatigue usage factor. The effect of corrosion on the applicable stresses is also evaluated and will consider prior service effects as well as expected service effects in the fatigue evaluation.

The fatigue analysis will not be affected by vibration because the anticipated repair locations are remote from the RCS pumps, or in the case of the cold leg RTD nozzles, the attached configuration is a very short cantilever, which will not impart any significant vibration loading onto the replacement weld.

A separate finite element model and analysis are used to develop the residual stresses in the original J-weld and nearby base metal. This approach uses techniques similar to those that have been used to model the residual stress in reactor vessel head penetrations. The results of this analysis are used as an input to the crack growth and fracture mechanics evaluation of the assumed crack at the original J-weld.

The assumed crack is assumed to grow into the base metal by fatigue crack growth. The analysis is consistent with the general outline of ASME Section XI Appendix A however details are specific to the J-weld geometry. The stress intensity factor range due to the various combinations of loading conditions and transients is calculated and the increment of crack growth for each cycle of the range is determined from Figure A-4300-1 of Section XI Appendix A using the curve that is appropriate to the PWR water environment. The total crack size is incremented by each transient cycle prior to recalculating the stress intensity factor range for the next cycle. The final bounding crack size at the end of anticipated life is thus determined and used for the structural integrity evaluation. The evaluation follows the requirements of Section XI IWB-3600, which ensures that structural stability is maintained with appropriate Code margins under all plant conditions. Since the instrument nozzle locations are remote from the reactor core, irradiation does not influence toughness properties.

The evaluation thus performed is specific to the replacement configuration and meets the intent of the ASME Code with no reduction in margin. Therefore structural integrity is maintained and the replacement configuration provides equivalent safety to original construction.

6.2 General Corrosion, Boric Acid Corrosion, and Stress Corrosion Cracking

In the half-nozzle repair/replacement design, a small gap remains between the remnant of the Alloy 600 nozzle and the new Alloy 690 nozzle. As a result, primary coolant (borated water) will fill the crevice between the nozzle and the wall of the component (e.g., the pressurizer, the steam generator channel heads, or the RCS piping). Low alloy and carbon steel base material is used for these reactor coolant pressure boundary components clad with stainless steel to minimize corrosion resulting from exposure to borated primary coolant. Since the crevice regions of the half-nozzle repair/replacement design are not clad, the low alloy and carbon steels are exposed to borated water.

Reference 7 evaluated the corrosion of the carbon steel by the exposure to borated water. This report demonstrated that the carbon and low alloy steel components will not be unacceptably degraded by general corrosion since the ferritic steel within the penetration is exposed to the primary coolant as a result of the half-nozzle repair/replacements. Some corrosion will occur but the amount is not expected to adversely affect ASME Code limits before the end of plant life including potential extended operation.

Reference 7 also evaluated the potential for stress corrosion cracking of the carbon steel by exposure to the high temperature, high purity, and borated water. This evaluation showed that the potential for stress corrosion cracking, either initiation or propagation, is eliminated because of the water chemistry that is maintained in a pressurized water reactor. Specifically the very low oxygen levels preclude either the initiation or propagation of stress corrosion cracking.

6.3 Radiation Exposure Estimates

The radiation dose estimates to perform a full nozzle replacement in lieu of a half-nozzle repair/replacement will result in personnel radiation exposures in the order of 5 times that expected for a half-nozzle repair/replacement activity. This increased exposure is based on the fact that to perform a full nozzle replacement will require internal access to each component involved. With this access the operations that must be performed to complete a full nozzle replacement include removal of a significant portion of the original nozzle to component weld, internal welding, grinding, fit-ups, and examination that would all be eliminated by a half-nozzle repair/replacement activity. The estimated personnel radiation exposure for one full instrument nozzle replacement in each of the components covered by this alternative request verses one half-nozzle repair/replacement is as follows:

Component	Exposure Estimate Full Nozzle (REM)	Exposure Estimate Half-Nozzle (REM)
Pressurizer	7.5 to 10.0	1.5 to 2.0
Steam Generator Channel Heads	7.5 to 10.0	1.5 to 2.0
RCS Piping Hot Legs	7.5 to 10.0	1.5 to 2.0
RCS Piping Cold Legs	10.0 to 12.5	2.0 to 2.5

Based on these estimates DNC has concluded that to perform a full nozzle replacement in lieu of a half-nozzle repair/replacement is not ALARA and therefore would represent an unusual difficulty and hardship if a full nozzle replacement had to be performed.

6.4 Personnel Safety Considerations

Relative to performing a half-nozzle repair/replacement on the pressurizer, the steam generator channel heads, or the RCS piping, there are no exceptional safety concerns because the work will be conducted on the outside surface of the component. Beyond routine safety awareness, the only unique concern for the task is that associated with welding and grinding.

Relative to performing a full nozzle replacement that requires access to the internal side of the component, the following safety concerns must be considered:

a. Entry into the pressurizer, the steam generator channel heads, or the RCS piping requires the application of safety precautions for a permit required confined space. This will require additional confined space attendants in radiation areas.

b. The confined space concern is complicated by the limited confines of the inside of the pressurizer, the steam generator channel heads, or the RCS piping and the welding evolution that will be required. The increased risk to personnel while working in confined spaces, is well documented in operating experience. Worker fatalities, loss of consciousness and near miss injuries have all occurred.

c. The confined space issue is further complicated by heat stress considerations. While conditions in the reactor containment do not normally pose a heat stress concern, conditions within the limited confines of the pressurizer, the steam generator channel heads, or the RCS piping are postulated to present a concern. This concern is founded in the understanding that the following conditions will hamper personnel effectiveness:

    - Grinding and welding activities will occur, providing a heat source.
    - Ventilation of the area is limited.
    - Personnel will be wearing heavy protective clothing to support radiological contamination control as well as hot work protection.
    - Personnel will be wearing airline respiratory protection for both radiological and confined space protections.
    - Personnel will be wearing full harness as required for confined space rescue.

d. Therefore the full extent of the radiological and industrial safety precautions that are associated with work within the confines of the pressurizer, the steam generator channel heads or the RCS piping, presents physical and psychological stress to those performing the work. This additional stress to personnel presents a human error precursor to a potentially threatening situation that will not be present with a half-nozzle repair replacement alternative.

6.5 Conclusion

In conclusion, for a repair/replacement of a leaking Alloy 600 small bore instrumentation nozzle, DNC has determined that to meet the requirements of ASME Section XI, 1989 Edition, no Addenda (reference 1), paragraph IWB-3142.5 "Acceptance by Replacements," would create a hardship and unusual difficulty without a compensating increase in the level of quality and safety. These requirements if met for a leaking instrumentation nozzle would require the nozzle or the portion of the nozzle containing a relevant condition/flaw to be replaced and would be very difficult to meet. The estimated radiation exposure and danger to personnel is excessive for this type of nozzle replacement, because internal component surface access is required in lieu of a half-nozzle repair/replacement that can be performed from the external surface. The half-nozzle repair/replacement design will meet the requirements of the 1992 Edition, ASME Code, Section III, and the 1992 Edition with the 1992 Addenda of Section II for materials ASME Section III (reference 6). The proposed alternatives will support not removing the entire nozzle and leaving the flaw in place, but will show by analysis that the material and the presence of the flaw will not be detrimental to the pressure retaining function of either the pressurizer, steam generator channel heads, or the RCS piping if a half-nozzle repair replacement is installed.

7.0 DURATION OF THE PROPOSED ALTERNATIVE:

The alternative in this request will be applied for the remainder of the current third 10-year ISI interval, which started on April 1, 1999. Once a half-nozzle repair/replacement is installed, the remnant nozzle will remain in place for the life of the plant, including the license renewal period and the half-nozzle repair will be considered a permanent replacement. The proposed alternative of this request will be applicable to any future replacement of Alloy 600 small bore nozzles in the pressurizer, the steam generator channel heads, or the RCS piping.

8.0 PRECEDENTS:

A similar request for the use of a half-nozzle repair of Alloy 600 small bore nozzles without flaw removal was submitted by the Florida Power and Light Company for the Saint Lucie Plants, Units 1 and 2 and was approved by the NRC on May 9, 2003 for one 18-month operating cycle, which began on October 2002 for Unit 1 and on May 2003 for Unit 2. The safety evaluation was listed under (TAC NOS. MB7199 and MB7200) and Docket Nos. 50-335 and 50-389.

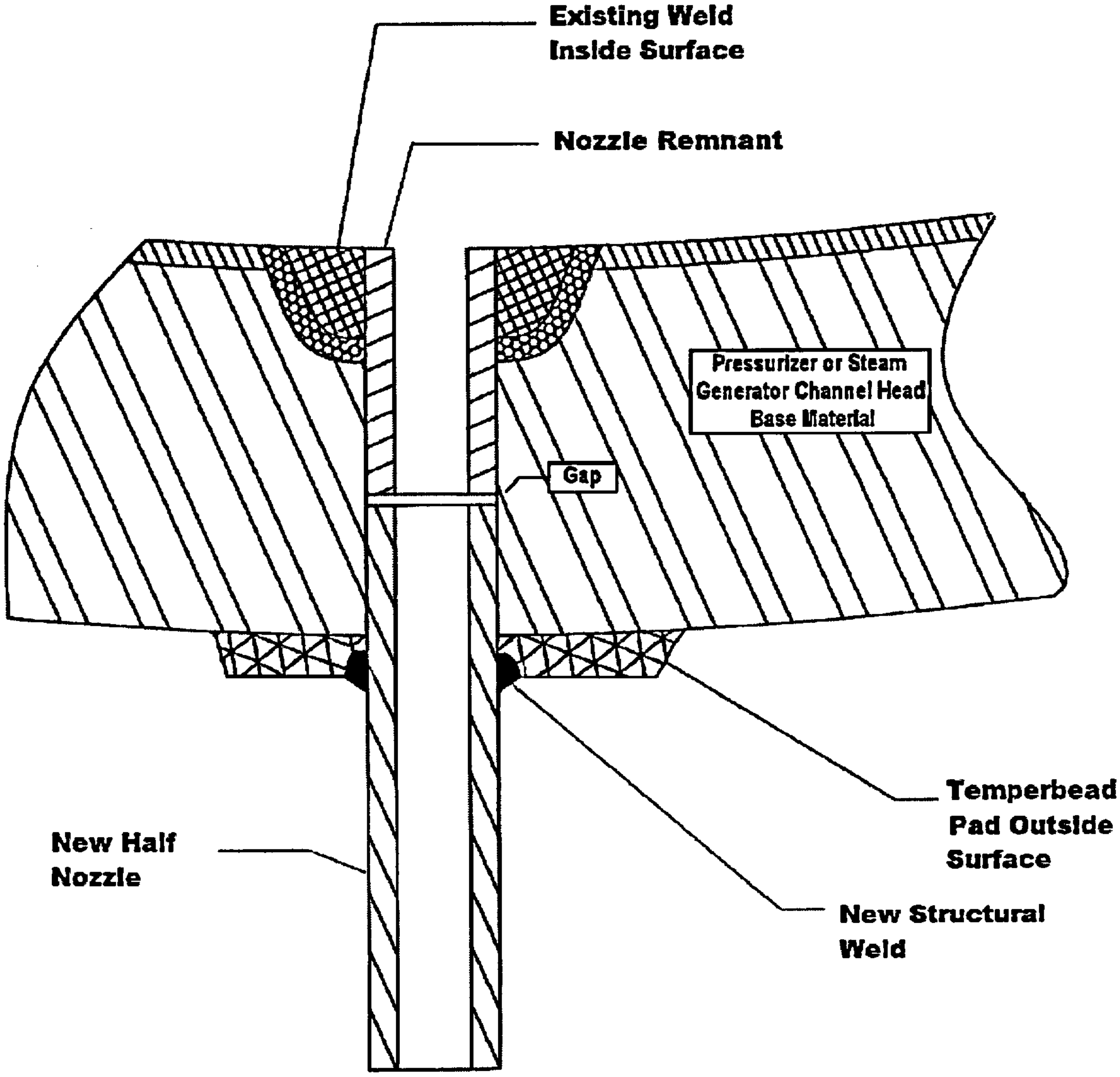

FIGURE 1:
TYPICAL HALF-NOZZLE REPAIR/REPLACEMENT WITH
A WELD PAD DEPOSIT

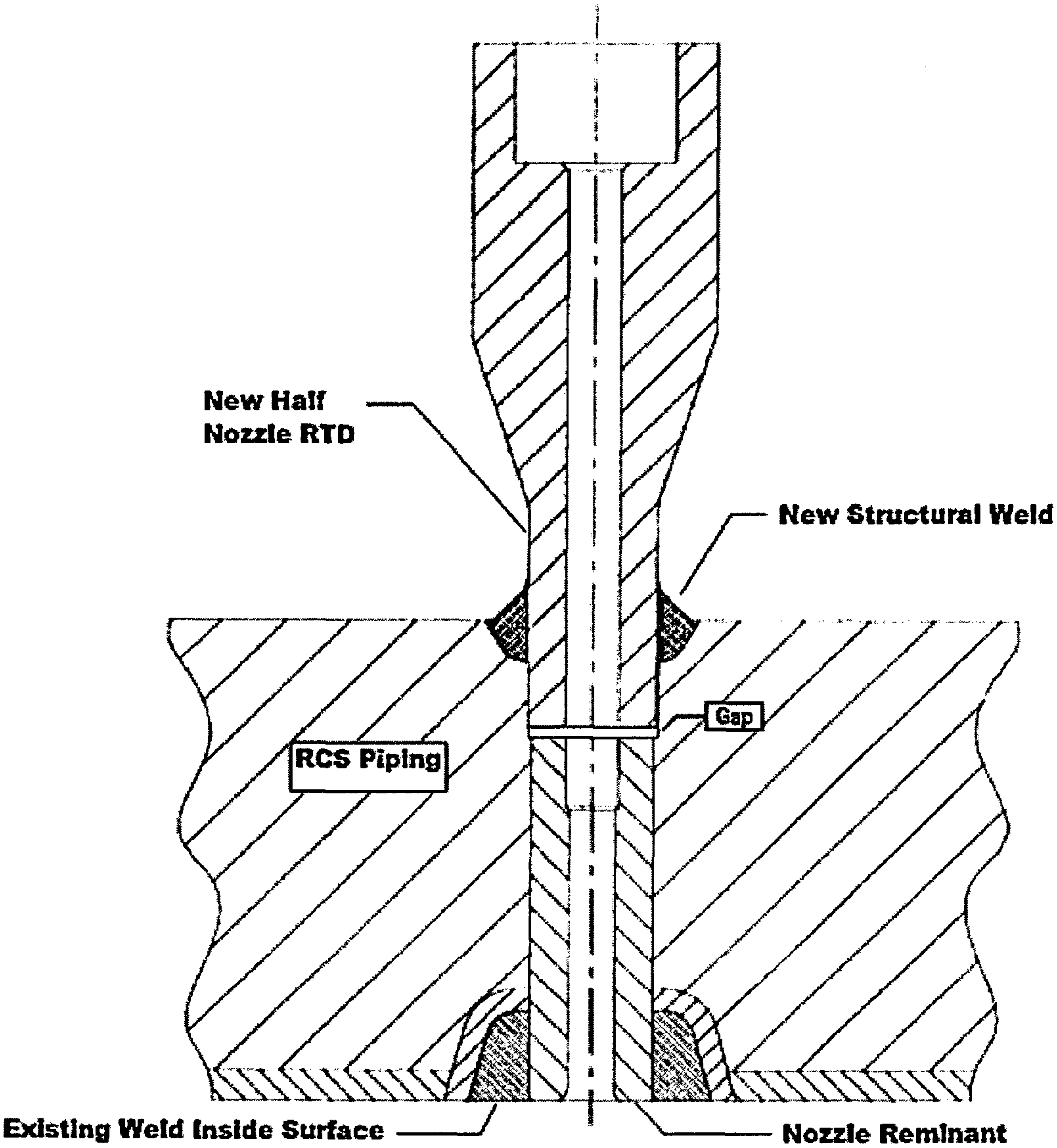

FIGURE 2: TYPICAL HALF-NOZZLE REPAIR/REPLACEMENT