Kewaunee Nuclear Power Plant
N490 Highway 42
Kewaunee, WI 54216-9511
920 388 2560

Point Beach Nuclear Plant
6610 Nuclear Road
Two Rivers, WI 54241
920.755 2321

NMC
Committed to Nuclear Excellence

Kewaunee / Point Beach Nuclear
Operated by Nuclear Management Company, LLC

NRC 2002-0073

10 CFR 50.55a(g)(5)(iii)
10 CFR 50.55a(a)(3)(i)

August 28, 2002

Document Control Desk
U. S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555

Ladies/Gentlemen:

Docket 50-266
Point Beach Nuclear Plant, Unit 1
Reactor Vessel Closure Head Penetration Repair
Relief Requests MR 02-018-1 and MR 02-018-2

In accordance with 10 CFR 50.55a(a)(3)(i) and 10 CFR 50.55a(g)(5)(iii), Nuclear Management Company (NMC) LLC, licensee for Point Beach Nuclear Plant (PBNP), is requesting the following relief requests which may become necessary in the event that flaws requiring repair in reactor vessel closure head (RVCH) penetrations are discovered during the upcoming inspection.

Relief Request MR 02-018-1 requests use of an alternative repair technique, as described below.

Relief Request MR 02-018-2 requests relief from the requirement to characterize flaws that may exist in the remnants of the control rod drive mechanism (CRDM) nozzle J-groove welds after the repair. This relief request would not apply if flaw removal via the machining process is verified by surface examination.

The repair plan seeks to significantly reduce radiation exposures for CRDM penetration repair by instituting remote machine processes and ambient temperature temper bead welding similar to those used at Surry Unit 1.

All repair equipment will be staged from underneath the RVCH using remotely operated equipment to the maximum practical extent. Each CRDM nozzle to be repaired will receive a roll expansion into the RVCH base material resulting in approximately 1-3% nozzle wall thickness reduction. The roll expansion will ensure that the nozzle will not move during the repair operations. Then, the lower portion of the nozzle, to a depth above the existing J-groove partial penetration weld will be removed by machining to approximately mid RVCH wall thickness.

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This operation will sever the existing J-groove partial penetration weld from the subject CRDM nozzle(s). The machining process will remove the entire lower portion of the CRDM nozzle and will also form the CRDM nozzle repair weld prep. The machined surface of the nozzle will be cleaned prior to liquid penetrant examination.

The repair weld will be performed with a machine Gas Tungsten Arc Welding (GTAW) weld head using the temper bead process using 50°F minimum preheat temperature as provided for in Code Case N-638. In some cases, depending on penetration location, a portion of the new weld may be partially deposited over a portion of the original weld. A new Alloy 52 pressure boundary weld between the shortened nozzle and the inside bore of the RVCH will be created. This approach for repair of the leaking CRDM nozzles will significantly reduce radiation dose to repair personnel. The projected dose saving per CRDM nozzle is approximately 30 REM.

Attachments 1 and 2 contain relief requests applicable to the Unit 1 reactor vessel head examinations being performed in accordance with our response to NRC Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs".

The PBNP Unit 1 fall 2002 refueling outage is scheduled to start on September 14, 2002. These examinations are currently planned on or near September 19, 2002. In light of BL 2002-02 dated August 9, 2002 and the imminent refueling outage, NMC requests NRC review and approval of these relief requests by September 30, 2002. If necessary, NMC personnel will be available to meet with your staff to discuss any concerns you may have.

Any statements of intent made in this submittal are provided for information purposes and are not considered to be regulatory commitments.

If you have any questions or require additional information, please contact us.

Sincerely,

Tom Webb

T. J. Webb
Regulatory Affairs Manager

Attachment 1 – Relief Request MR 02-018-1 with Enclosure 1, Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique
Attachment 2 – Relief Request MR 02-018-2

cc: NRC Resident Inspector
NRC Regional Administrator
NRC Project Manager
PSCW

Attachment 1
To the Letter

From:

T. J. Webb (NMC)

To:

US NRC Document Control Desk

Dated:

August 28, 2002

Reactor Vessel Closure Head Penetration Repair
Relief Request MR 02-018-1
Point Beach Nuclear Plant Unit 1

POINT BEACH NUCLEAR PLANT
REACTOR VESSEL CLOSURE HEAD PENETRATION REPAIR
RELIEF REQUEST MR 02-018-1

Relief Request No. MR 02-018-1, Alternate Repair Technique – Reactor Vessel Closure Head Penetrations

Pursuant to 10 CFR 50.55a(a)(3)(i), PBNP requests alternative repair techniques in the event that [illegible]

RELIEF REQUESTED

Nuclear Management Company (NMC) requests relief to use an ambient temperature temper bead method of repair as an alternative to the requirements of the 1989 Edition of ASME Section III, NB-4453, NB-4622, NB-5245, and NB-5330. The requirements of paragraph QW-256 of ASME Section IX, and IWA-4000 of the 1998 Edition, 2000 Addenda of Section XI, are also applicable to the proposed repairs. Approval is requested to use filler material Alloy 52 AWS Class ERNiCrFe-7/UNS No. 06052, which is endorsed by Code Case 2142-1, for the weld repair. Portions of Code Case N-638 as described herein have also been used as a template for this application. 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.

BASIS FOR RELIEF

For the proposed repairs to the reactor vessel closure head penetrations, paragraph N-528.2 of the 1965 Edition of Section III requires repairs be PWHT in accordance with paragraph N-532. The PWHT requirements set forth therein would be impossible to attain on a RVCH in containment without distortion of the head. Because of the inability to comply with the requirements of the original Construction Code, the rules of ASME Section III, 1989 Edition, no Addenda will be applied to the repairs (with the exceptions noted herein). For any RVCH penetration flaws that resulted in a repair within 1/8-inch of the ferritic material of the RVCH, paragraph NB-4622 of Section III would require a PWHT for the repair weld or the use of a temper bead weld technique. The temper bead 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 temper bead procedure proposed below. Therefore, pursuant to 10 CFR 50.55a (a)(3)(i), NMC requests relief to use an ambient temperature temper bead welding method of repair as an alternative to the requirements of the 1989 Edition, no Addenda of ASME Section III, NB-4622.

ALTERNATIVE DOCUMENTATION AND REQUIREMENTS

Repairs to RVCH 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 IWA-4000 of the 1998 Edition, 2000 Addenda of ASME Section XI. The requirements of paragraphs NB-4622, and NB-5245, of the 1989 Edition of ASME Section III are also applicable to the contemplated repairs. Applicable alternatives to these requirements per 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, paragraphs, and subparagraphs of ASME Section III, Section IX, and Section XI:

1. NB-4622.1 establishes the requirement for PWHT of welds including repair welds. In lieu of the requirements of this subparagraph, we propose to utilize a temper bead weld procedure obviating the need for PWHT.

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

3. 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.

4. 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.

5. 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.

6. 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.

7. NB-4622.7 establishes exemptions from mandatory PWHT requirements. Sub-subparagraphs 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. Sub-subparagraph 4622.7(g) discusses exemptions to weld repairs to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. This sub-subparagraph does not apply because the ambient temperature temper bead repair is being proposed as an alternative to the requirements of subparagraph NB-4622.11.

8. NB-4622.8 establishes exemptions from PWHT for nozzle to component welds and branch connection to run piping welds. Sub-subparagraph 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 1/4 inch thick, which will not exist for the welds in question. Sub-subparagraph 4622.8(b) also does not apply because it discusses full penetration welds and the welds in question are partial penetration welds.

9. 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 F-No. 43 filler metals.

10. 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.

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

    A. NB-4622.11(a) requires surface examination prior to repair in accordance with NB-5000. The proposed alternative will include surface examination prior to repair consistent with NB-5000.

    B. 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. The proposed alternative will include the same limitations on the maximum extent of repair.

    C. 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 will satisfy these requirements, except for the stipulations of paragraph QW-256 of Section IX as explained in the Justification for Relief below. In addition, NB-4622.11 (c) requires the welding procedure specification include the following requirements:

        1) NB-4622.11(c)(l) 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.

        2) NB-4622.1l(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 uses gas tungsten arc welding (GTAW) with bare electrodes and bare filler metal meeting the F-No. 43 classification.

        3) 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 and bare filler metal that do not require storage in heated ovens because bare electrodes nor bare filler metal will not pick up moisture from the atmosphere as covered electrodes may.

        4) 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 and bare filler metal, which do not require any special storage conditions to prevent the pick up of moisture from the atmosphere.

5) NB-4622.11(c)(5) requires preheat of the weld area and 1 ½ T or 5 inch band, whichever is less, to a minimum temperature of 350°F prior to repair welding and a maximum interpass temperature of 450°F. Thermocouples and recording instruments shall be used to monitor the metal temperature during welding. The proposed ambient temperature temper bead alternative does not require an elevated temperature preheat. Interpass temperature measurements cannot be accomplished due to inaccessibility in the weld region. Therefore, the maximum interpass temperature will be determined by calculation as shown in the Justification for Relief below.

6) 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 machine GTAW, the requirement to remove the weld crown of the first layer is unnecessary and the proposed alternative does not include the requirement.

7) 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 temper bead procedure does not require the hydrogen bake out

8) 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 350°F (maximum) and requires the area to be welded be at least 50°F prior to welding. This approach has been demonstrated to be adequate to produce sound welds.

9) NB-4622.1 l(d)(l) 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 out because it is unnecessary for the very low hydrogen GTAW temper bead process.

10) NB-4622.1l(d)(2) requires liquid penetrant and radiographic examinations of the repair welds and the preheated band after a minimum time of 48 hours at ambient temperature. Ultrasonic inspection is required if practical. The proposed alternative 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 (due to limitations on access for source and film placement and the likelihood of unacceptable geometric unsharpness and film density), final inspection will be by liquid penetrant and ultrasonic examination. Also, due to the repair configuration and accessibility,

the weld and immediate surrounding area only will be liquid penetrant and ultrasonically examined.

11) NB-4622.11(d)(3) requires that all nondestructive examination be in accordance with NB-5000. The proposed alternative will comply with NB-5000 except that the progressive liquid penetrant examination required by NB-5245 will not be done. In lieu of the progressive liquid penetrant examination, the proposed alternative will use liquid penetrant and ultrasonic examination of the final weld.

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

13) NB-4622.11(f) establishes requirements for the procedure qualification test plate. The proposed alternative complies with those requirements.

14) 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 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.

15) 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 in accordance with the proposed alternatives will be partial penetration welds as described by NB- 4244(d) and will meet the weld design requirements of NB-3352.4(d). For these partial penetration welds, paragraph NB-5245 requires a progressive surface exam (PT or MT) at the lesser of 1/2 the maximum weld thickness or 1/2-inch, as well as on the finished weld. For the proposed alternative, the repair weld will be examined by a liquid penetrant and ultrasonic no sooner than 48 hours after the weld has cooled to ambient temperature in lieu of the progressive surface exams required by NB-5245. The volumetric examination coupled with surface examination will provide a high level of confidence that the proposed welds are sound and defect free.

16) NB-5330(b)does not allow any cracks or incomplete penetration regardless of length. Framtome's experience is that a linear indication often occurs at the intersection of the RVCH, the nozzle, and the first intersecting weld bead (triple point). The proposed alternative will allow this triple point indication to remain.

17) Paragraph QW-256 of ASME Section IX requires that the maximum interpass temperature during procedure qualification be no more than 100F below that used for actual welding. The maximum interpass temperature during welding is specified to be 350F maximum. The maximum interpass temperature during the procedure qualifications was less than 100°F.

JUSTIFICATION OF RELIEF

The alternative to NB-4622 requirements being proposed involves the use of an ambient temperature temper bead welding technique that avoids the necessity of traditional PWHT, preheat and postweld heat soaks. The welding technique described in Enclosure 1, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique", is similar to the requirements of Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique" which has been tentatively approved in Proposed Regulatory Guide 1.147, Rev 13 (Draft Regulatory Guide DG-1091 dated Dec 2001). The proposed welding technique differs from that described in sections 1.0 through 4.0 of Code Case N-638 as follows:

a) N-638 2.1(b) requires consideration be given to the effects of welding in a pressurized environment. This requirement is not applicable because the welding will not occur in a pressurized environment.

b) N-638 2.1(c) requires consideration be given to the effects of irradiation on the properties of materials in the core belt line region. This requirement is not applicable because the welding will be on the RVCH, not in the belt line region.

c) N-638 2.1 (g) requires ferritic base material used in the welding procedure qualification to meet the impact test requirements of the Construction Code and Owners Requirements. If such requirements are not in the Construction Code and Owners 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.

d) N-638 2.1(h) specifies Charpy V notch requirements for ferritic weld material of the procedure qualification. The filler material is F-No. 43, which is not ferritic. Therefore this requirement does not apply.

e) N-638 2.1 (j) requires the three heat affected zones (HAZ) impact tests be equal or greater than the unaffected base material tests. Charpy impact testing during the welding procedure qualification process resulted in the average mils lateral expansion for the HAZ being less than the average values for the base material. Additional tests were conducted on the HAZ material as permitted by NB-4335.2 to determine an additive temperature to the RT_{NDT}.

f) N-638 3.0(c) requires a layer of weld reinforcement be applied and then machined to a flush surface. This requirement is not applicable because the welding will join dissimilar metals with non-ferritic weld filler metal.

g) N-638 3.0(d) specifies the maximum interpass temperature for field applications shall be 350°F regardless of the interpass temperature during qualification. N-638 2.1(e) specifies the maximum interpass temperature for the first three layers of the test assembly shall be 150°F. QW-256 specifies maximum interpass temperature as a supplementary essential variable that must be held within 100 °F above that used during procedure qualification. See justification below for variation to the requirements of QW-256.

h) N-638 3.0(e) requires care be taken to ensure that the weld region is free of all potential sources of hydrogen. As described below, the proposed alternative temper bead procedure utilizes a welding process that is inherently free of hydrogen.

i) N-638 4.0(b) requires the final weld surface and band around the area defined in paragraph 1.0(d) to be examined using surface and Ultrasonic Testing (UT) methods. The purpose for the examination of the band is to assure all flaws associated with the weld repair area have been removed or addressed. However, the band around the area defined in paragraph 1.0(d) cannot be examined due to the physical configuration of the partial penetration weld. The final examination of the new weld and immediate surrounding area within the band will be sufficient to verify that defects have not been induced in the low alloy reactor vessel closure head material due to the welding process. Liquid penetrant (PT) coverage is shown in Figures 5 and 6 . UT will be performed scanning from the ID surface of the weld, excluding the transition taper portion at the bottom of the weld and adjacent portion of the CRDM nozzle bore. The UT is qualified to detect flaws in the repair weld and base metal interface in the repair region, to the maximum practical extent. Ultrasonic examination acceptance criteria will be in accordance with NB-5350. The examination extent is consistent with the Construction Code requirements.

j) N-638 4.0(c) requires areas which had weld-attached thermocouples attached to be ground and examined using a surface examination. This requirement will be met if thermocouples are used.

k) N-638 4.0(e) requires UT examination acceptance criteria to be in accordance with IWB- 3000. The proposed welding technique requires UT acceptance criteria in accordance with NB-5330.

The features of the alternative repair technique that makes it applicable and acceptable for the contemplated repairs are enumerated below:

a) 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 welds of P-No. 3, RVCH material to P-No. 43 CRDM nozzle material using F-No. 43 filler material.

b) The use of a GTAW ambient temperature temper bead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by EPRI (EPRI Report GC-I 11050, "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 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 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 HAZ in both cases. The ambient temperature temper bead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed.

c) The NB-4622.11(c)(2) temper bead 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 temper bead procedures require preheat and postweld hydrogen bake-out. However, the proposed alternative temper bead procedure utilizes a welding process that is inherently free of hydrogen. The GTAW process relies on bare welding electrodes 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. 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 GTAW process will be shielded with welding grade argon, which typically produces porosity free welds. 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.

d) The F-No. 43 (ERNiCrFe-7) filler metal that would be used for the repairs is not subject to hydrogen embrittlement cracking. Code Case 2142-1 endorses the use of Alloy AWS Class ERNiCrFe-7/UNS No. 06052.

e) Final examination of the repair welds would be by surface examination (liquid penetrant) and ultrasonic 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.

f) 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.

g) The P-No. 43 to P-No. 3 welding procedure specifies a maximum interpass temperature of 350°F. The welding procedure was qualified with an interpass temperature less than 100°F. Per QW-256 of ASME Section IX an increase greater than 100°F is a supplementary essential variable. The procedure qualification requirements recommended in Code Case N-638 imposes a 150°F maximum interpass temperature during the welding of the procedure qualification. This requirement restricts base metal heating during qualification that could produce slower cooling rates that are not achievable during field applications. However, this requirement does not apply to field applications as a 350°F maximum interpass temperature is a requirement in Section 3.0 of Code Case N-638. The higher interpass temperature is permitted because it would only result in slower cooling rates which could be helpful in producing more ductile transformation products in the HAZ.

   Framatome-ANP (FRA-ANP) has qualified the Machine GTAW of P-No. 3, low alloy steel base materials to P-No. 43 Inconel alloy base materials with the "Ambient Temperature Temper Bead Weld Technique" in accordance with the rules of ASME Code Case N-638. The qualifications were performed at room temperature with water backing on the backside of the weld to maintain the maximum interpass temperature to a maximum of 100°F. The qualifications were performed on the same P-No. 3, Group No. 3 base material as proposed for the CRDM repairs, using the same filler material (i.e. Alloy 52 AWS Class ERNiCrFe-7 with similar low heat input controls as will be used in the repairs. Also, the qualifications did not include a post weld heat soak. Based on FRA-ANP prior welding procedure qualification test data using machine GTAW ambient temperature temper bead welding, quality temper bead welds can be performed with 50°F minimum preheat and no post weld heat treatment.

h) As discussed previously, NB-5245 requires progressive surface examination of the proposed partial penetration welds while the alternative requires final surface examination (liquid penetrant inspection) and volumetric examination (ultrasonic inspection) which will provide added assurance of sound welds when done in conjunction with the planned system leak test. Due to the welding layer deposition sequence, i.e., each layer is deposited parallel to the penetration centerline, the specific requirements of NB-5245, as specified, cannot be met. In any case, the Construction Code original required progressive PT in lieu of volumetric examination because volumetric examination is not practical for the conventional partial penetration weld configurations. In this case the weld is suitable, except of the taper transition, for ultrasonic examination and a final surface liquid penetrant examination can be performed. The final examination of the new weld repair and immediate surrounding area within the band will be sufficient to verify that defects have not been induced in the low alloy reactor vessel closure head material due to the welding process. Liquid Penetrant (PT) coverage is shown in Figures 5 and 6. UT will be performed scanning from the ID surface of the weld, excluding the transition taper portion at the bottom of the weld and adjacent portion of the CRDM nozzle bore. The UT is qualified to detect flaws in the repair weld and base metal interface in the repair region, to the maximum practical extent. Ultrasonic examination acceptance criteria will be in accordance with NB-5350. The examination extent is consistent with the Construction Code requirements.

i) The RVCH preheat temperature will be essentially the same as the reactor building ambient temperature; therefore, RVCH preheat temperature monitoring in the weld region and using thermocouples is unnecessary and would result in additional personnel dose associated with thermocouple placement and removal. Consequently, preheat temperature verification by use of contact pyrometer on accessible areas of the closure head is sufficient. In lieu of using thermocouples for interpass temperature measurements, calculations show that the maximum interpass temperature will never be exceeded based on a maximum allowable low welding heat input, weld bead placement, travel speed, and conservative preheat temperature assumptions. The calculation supports the conclusion that using the maximum heat input through the third layer of the weld, the interpass temperature returns to near ambient temperature. Heat input beyond the third layer will not have a metallurgical effect on the low alloy steel HAZ.

The calculation is based on a typical inter-bead time interval of five minutes. The five minute inter-bead interval is based on: 1) the time required to explore the previous weld deposit with the two remote cameras housed in the weld head, 2) time to shift the starting location of the next weld bead circumferentially away from the end of the previous weld-bead, and 3) time to shift the starting location of the next bead axially to insure a 50% weld bead overlap required to properly execute the temper bead technique.

A welding mockup on the full size Midland RVCH, which is similar to Point Beach Unit 1 RVCH, was used to demonstrate the welding technique described here in. During the mockup, thermocouples were placed to monitor the temperature of the closure head during welding. Thermocouples were placed on the outside surface of the closure head within a 5-inch band surrounding the CRDM nozzle. Three other thermocouples were placed on the closure head inside surface. One of the three thermocouples was placed 1-1/2 inches from the CRDM nozzle penetration, on the lower hillside. The other inside surface thermocouples were placed at the edge of the 5-inch band surrounding the CRDM nozzle, one on the lower hillside, the second on the upper hillside. During the mockup, all thermocouples fluctuated less than 15°F throughout the welding cycle. Based on past experience, it is believed that the temperature fluctuation was due more to the resistance heating temperature variations than the low heat input from the welding process. For the Midland RVCH mockup application, 300°F minimum preheat temperature was used. Therefore, for ambient temperature conditions used for this repair, maintenance of the 350°F maximum interpass temperature will certainly not be a concern.

j) UT will be performed in lieu of RT due to the repair weld configuration. Meaningful RT cannot be performed as can be seen in the applicable figures, attached. The weld configuration and geometry of the penetration in the head provide an obstruction for the x-ray path and interpretation would be very difficult. UT will be substituted for the RT and qualified to evaluate defects in the repair weld and at the base metal interface. This examination method is considered adequate and superior to RT for this geometry. The new structural weld is sized like a coaxial cylinder partial penetration weld. ASME Code Section III construction rules require progressive PT of partial penetration welds. The Section III original requirements for progressive PT were in lieu of volumetric examination. Volumetric examination is not practical for the conventional partial penetration weld configurations. In this case the weld is suitable, except of the taper transition, for UT and a final surface PT will be performed.

The effectiveness of the UT techniques to characterize the weld defects has been qualified by demonstration on a mockup of the repair temper bead weld involving the same materials used for repair. Notches were machined into the mockup at depths of 0.10", 0.15", and 0.25" in order to quantify the ability to characterize the depth of penetration into the nozzle. The depth characterization is done using tip diffraction UT techniques that have the ability to measure the depth of a reflector relative to the nozzle bore. Each of the notches in the mockup could be measured using the 45 degree transducer. During the examination longitudinal wave angle beams of 45 degrees and 70 degrees are used. These beams are directed along the nozzle axis looking up and down. The downward looking beams are effective at detecting defects near the root of the weld because of the impedance change at the triple point (intersection of weld material, penetration tube, and vessel head). The 45-degree transducer is effective at depth characterization by measuring the time interval to the tip of the reflector relative to the transducer contact surface. The 70-degree longitudinal wave provides additional qualitative data to support information obtained with the 45-degree transducer. Together, these transducers provide good characterization of possible defects. These techniques are routinely used for examination of austenitic welds in the nuclear industry for flaw detection and sizing.

In addition to the 45 and 70-degree beam angles described above, the weld is also examined in the circumferential direction using 45-degree longitudinal waves in both the clockwise and counterclockwise directions to look for transverse fabrication flaws. A 0-degree transducer is also used to look radially outward to examine the weld and adjacent material for laminar type flaws and evidence of under bead cracking.

The UT transducers and delivery tooling are capable of scanning from cylindrical surfaces with inside diameters near 2.75 inches. The UT equipment is not capable of scanning from the face of the taper. Approximately 70% of the weld surface will be scanned by UT. Approximately 83% of the RVCH ferritic steel HAZ will be covered by the UT. The transducers to be used are shown in Table 1. The UT coverage volumes are shown in Figures 7 through 12 for the various scans. Additionally, the final modification configuration and surrounding ferritic steel area affected by the welding is either inaccessible or extremely difficult to access, to obtain the necessary scans.

UT of the repair weld and HAZ are limited by the repair configuration. As can be observed from Figure 4, the CRDM nozzle weld repair configuration limits access to the ferritic steel base material above the weld as well as scanning from the taper at the bottom of the weld. See also Figures 7 through 12 and Table 1.

k) The PT examination extent is consistent with the Construction Code requirements. The final modification configuration and surrounding ferritic steel area affected by the welding is either inaccessible or extremely difficult to access.

Liquid penetrant examination of the entire ferritic steel bore will be performed after removal by boring of the lower end of the existing CRDM nozzle prior to welding.

As can be observed from Figures 4, the configuration of the new CRDM nozzle repair configuration limits access to the ferritic steel base material. The ferritic steel base material area above the new weld is inaccessible due to the CRDM nozzle. The ferritic steel closure head base material, below the new weld and within 1/2 inch of the bottom weld toe, will be liquid penetrant examined subsequent to welding.

l) The welding head 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.

m) An artifact of the temper bead weld repair is an anomaly in the weld at the triple point. The triple point is the point in the repair weld where the low alloy head, the Alloy 600 nozzle and the first Alloy 52 weld bead intersect. This anomaly consists of an irregularly shaped void. Mock-up testing has verified that the anomalies are common and do not exceed 0.1 in. in length and appear to exist around the entire bore (360°) at the "triple point" elevation. As described below, this anomaly is considered to be a planar flaw.

A fracture mechanics analysis will be performed to provide justification, in accordance with Section XI of the ASME Code, for operating with the postulated weld anomaly described above. The anomaly will be modeled as a 0.1 in. semi-circular "crack-like" defect, 360 degrees around the circumference at the "triple point" location. Postulated flaws could be oriented within the anomaly such that there are two possible flaw propagation paths, as discussed below.

Path 1:

Flaw propagation path 1 that traverses the CRDM tube wall thickness from the OD of the tube to the ID of the tube. This is the shortest path through the component wall, passing through the new weld material. However, Alloy 600 tube material properties or equivalent will be used to ensure that another potential path through the HAZ between the new repair weld and the Alloy 600 tube material is bounded.

For completeness, two types of flaws will be postulated at the outside surface of the tube. A 360° continuous circumferential flaw, lying in a horizontal plane, will be considered to be a conservative representation of crack-like defects that may exist in the weld anomaly. This flaw will be subjected to axial stresses in the tube. An axially oriented semi-circular outside surface flaw will also be considered since it would lie in a plane normal to the higher circumferential stresses. Both of these flaws would propagate toward the inside surface of the tube.

Path 2:

Flaw propagation path 2 runs down the outside surface of the repair weld between the weld and RVCH. A continuous cylindrically oriented flaw will be postulated to lie along this interface, subjected to radial stresses with respect to the tube. This flaw may propagate through either the new weld material or the low alloy steel RVCH material.

The results of the analysis will demonstrate that a 0.10 inch weld anomaly will be acceptable for a design life of the CRDM ID temper bead weld repair. Significant fracture toughness margins will be obtained for both of the flaw propagation paths considered in the analysis. The minimum calculated fracture toughness margins, are expected to be significantly greater than the required margin of $\sqrt{10}$ per Section XI, IWB-3612. Fatigue crack growth will be minimal. The maximum final flaw size is expected to be approximately the same as the original assumed flaw size considering both flaw propagation paths. A limit load analysis will also be performed considering the ductile materials along flaw propagation path 1. The analysis will show limit load margins for normal/upset conditions and emergency/faulted conditions that will be significantly greater than the required margins of 3.0 and 1.5 for normal/upset conditions and emergency/faulted conditions, respectively, per Section XI, IWB-3642.

This evaluation will be prepared in accordance with ASME Section XI and demonstrate that for the intended service life of the repair, the fatigue crack growth will be acceptable and the crack-like indications remain stable. These two findings will satisfy the Section XI criteria but will not include considerations of stress corrosion cracking such as primary water stress corrosion cracking (PWSCC) or residual stresses.

Since the crack-like defects are not exposed to the primary coolant and the air environment is benign for the materials at the triple point, the time-dependent crack growth rates from PWSCC are not applicable regardless of residual stresses.

Residual stresses may also require consideration for ductile tearing when operating stresses are superimposed. The residual stress field by itself cannot promote ductile tearing or it would not be stable during welding. The anomalies have been shown to be stable by welding mock-ups simulating the actual geometry and materials. Even though the residual stresses for this type of weld would be very complex, it is apparent that by the size of the weld and the nature of the restraint that the residual stresses would have limited effect on driving a crack. The weld residual stresses are not like piping thermal expansion stresses where there may be considerable stored energy in long runs of pipe. The weld residual stresses are imposed by the inability of the weld bead to shrink to a nominal strain condition upon cooling. The attachment of the weld to the surrounding material generally promotes tensile stresses in the bead upon cooling. However even though the stresses are generally at the yield strength, the accompanying strains are not large due to the limited size of the beads and in this case the total size of the weld.

It is concluded that the residual stress field would produce a minimal ductile tearing driving force in the NiCrFe materials that are extremely crack-tolerant when not in an aggressive environment. The Section XI evaluation performed will be adequate, residual stresses need not be considered because PWSCC effects are not applicable, and the geometry is not conducive to sustained ductile tearing

The automated repair method described above leaves a band of ferritic low alloy steel exposed to the primary coolant. The effect of corrosion on the exposed area, both reduction of RVCH thickness and primary coolant Iron (Fe) release rates, has been evaluated by FRA-ANP. The results of this evaluation concluded that the total corrosion would be insignificant when compared to the thickness of the RVCH. FRA-ANP has estimated that the total estimated Fe release from a total of 69 repaired CRDM nozzles would be significantly less than the total Fe release from all other primary sources. Since Point Beach Unit 1 has only 49 RVCH nozzles, this estimate is bounding.

By using this alternative to the requirements, an acceptable level of quality and safety will be achieved.

IMPLEMENTATION SCHEDULE

This relief requested is intended to cover repair activities that may become necessary as a result of RVCH inspection activities occurring during the Unit 1 refueling outage. The PBNP Unit 1 fall 2002 refueling outage is scheduled to start on September 14, 2002. These examinations are currently planned on or near September 19, 2002 with repairs starting on or near September 30, 2002.

Enclosure 1 to Attachment 1

Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique

NMC plans to perform CRDM nozzle penetration repairs by welding the RVCH (P-No. 3 base material) and CRDM nozzle (P-No. 43 base material) with filler material F-No. 43, in accordance with the following:

1.0 General Requirements:

(a) The maximum area of an individual weld based 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 1½ 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 Cases specified in the repair/replacement plan. Welding materials will be controlled so that they are identified as acceptable until consumed.

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 ferritic steel base material for the welding procedure qualification is P-No.3 Group No. 3, which is the same P-No. and Group No. as the low alloy steel closure head base material to be welded. The ferritic base material shall be postweld heat treated to at least the time and temperature that was applied to the materials being welded. The other base material is P-No. 43. The filler metal is F-No. 43.

(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 1.

(e) Ferritic base material for the procedure qualification test will 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 subparagraph (f) below, but shall be in the base metal.

(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, Figure 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. The welding procedure has been qualified in accordance with the requirements of paragraphs 2.0 and 2.1 specified in the Alternative Welding Method with the exception that the requirements of NB-4335 of the 1995 Edition through the 1996 Addenda of ASME Section III were used to verify the Charpy impact properties of the ambient temperature temper bead welding process.

During the Charpy impact testing portion of the qualification process, the reference temperature (RT_{NDT}) was determined to be -30°F. At RT_{NDT} +60°F temperature (+30°F), the average of the HAZ absorbed energy Charpy impact tests was greater than the average of the base material. However, the average of the mils lateral expansion for the HAZ was less than the average values for the base material. Additional Charpy V-notch tests were conducted on the HAZ material as permitted by NB-4335.2 to determine an additive temperature to the RT_{NDT} temperature. The average mils lateral expansion for the HAZ at +35°F was equivalent to the unaffected base material at +30°F. These test results require an adjustment temperature of +5°F to the RT_{NDT} temperature for base material on which welding is performed.

Based on the criteria established in BAW-10046A, Methods of Compliance with Fracture Toughness and Operational Requirements of 10 CFR 50, Appendix G, the controlling item in the closure head assembly is the RVCH flange forging. This value is established to be +60F for the RT_{NDT} for the reactor flange forging. The RT_{NDT} established for the RVCH center disc plate was +40F. The same value was established for all the plate materials of the B&WOG plants as established in BAW-10046A. Since the welding will be done on the RVCH center disc plate, the new RT_{NDT} for this item would be +45F which is still less than+60F for the flange so therefore no impact on the technical specifications relevant to the RVCH component should occur.

The 1995 Edition through the 1996 Addenda of ASME Section III is referenced in 10 CFR 50.55a(b)(1). No limitations or modifications regarding the use of NB-4335 are noted in 10 CFR 50.55a. Therefore, the use of the methodology of NB-4335.2 to determine the additive temperature when the Charpy-V notch lateral expansion average values of the three HAZ test specimens has received NRC endorsement.

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 machine GTAW process.

(b) Dissimilar metal welds shall be made using F-No. 43 weld metal (QW-432) for P-No. 43 to P-No. 3 weld joints.

(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 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 will 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 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. The new weld is inaccessible for mounting thermocouples near the weld. Therefore, thermocouples will not be used to monitor interpass temperature. Preheat temperature will be monitored using contact pyrometer(s) and/or thermocouple(s), on accessible areas of the closure head external surface(s).

4.0 Examination

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

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

(c) The final weld surface and adjacent HAZ shall be examined using surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours.

The purpose for the examination of the band is to assure all flaws associated with the weld repair area have been removed or addressed. However, the band around the area defined in paragraph 1.0(d) cannot be examined due to the physical configuration of the partial penetration weld. The final examination of the new weld repair and immediate surrounding area within the band will be sufficient to verify that defects have not been induced in the low alloy reactor vessel head material due to the welding process. Liquid penetrant (PT) coverage is shown in Figures 5 and 6. Ultrasonic testing (UT) will be performed scanning from the ID surface of the weld, excluding the transition taper portion at the bottom of the weld and adjacent portion of the CRDM nozzle bore. The UT is qualified to detect flaws in the repair weld and base metal interface in the repair region, to the maximum practical extent. The examination extent is consistent with the Construction Code requirements.

(d) NDE personnel will be qualified in accordance with IWA-2300 or NB-5500.

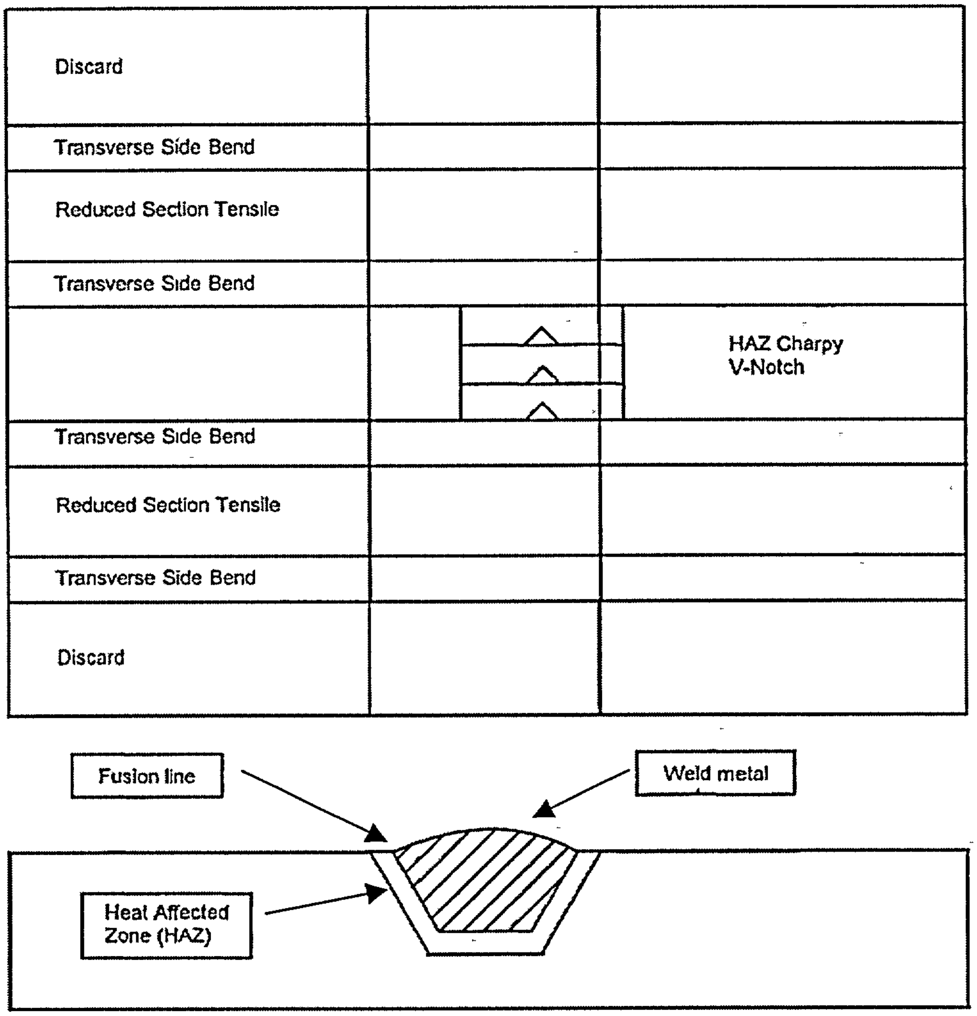
(e) Surface examination acceptance criteria will be in accordance with NB-5350. Ultrasonic examination acceptance criteria will be in accordance with NB-5330.

5.0 Documentation

Repairs will be documented on Form NIS-2.

Table 1:
Point Beach CRDM Replacement Weld
UT Search Unit Transducer Characteristics

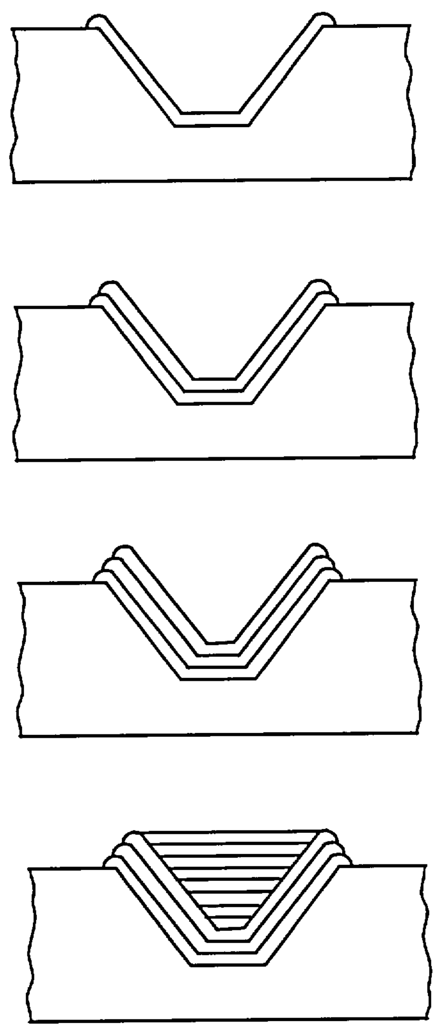
Angle/Mode	Freq.	Size	Focal Depth	Beam Direction
0° L-wave	2.25 MHz	.15" x .30"	0.45"	N/A
45° L-wave	2.25 MHz	.30" x .20"	0.45"	Axial
70° L-wave	2.25 MHz	.72" x .21"	0.69"	Axial
45° L-wave (effective)	2.25 MHz	.30" x .20"	0.45"	Circ.



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

QUALIFICATION TEST PLATE

Figure 1



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

AUTOMATIC OR MACHINE (GTAW) TEMPERBEAD WELDING

Figure 2

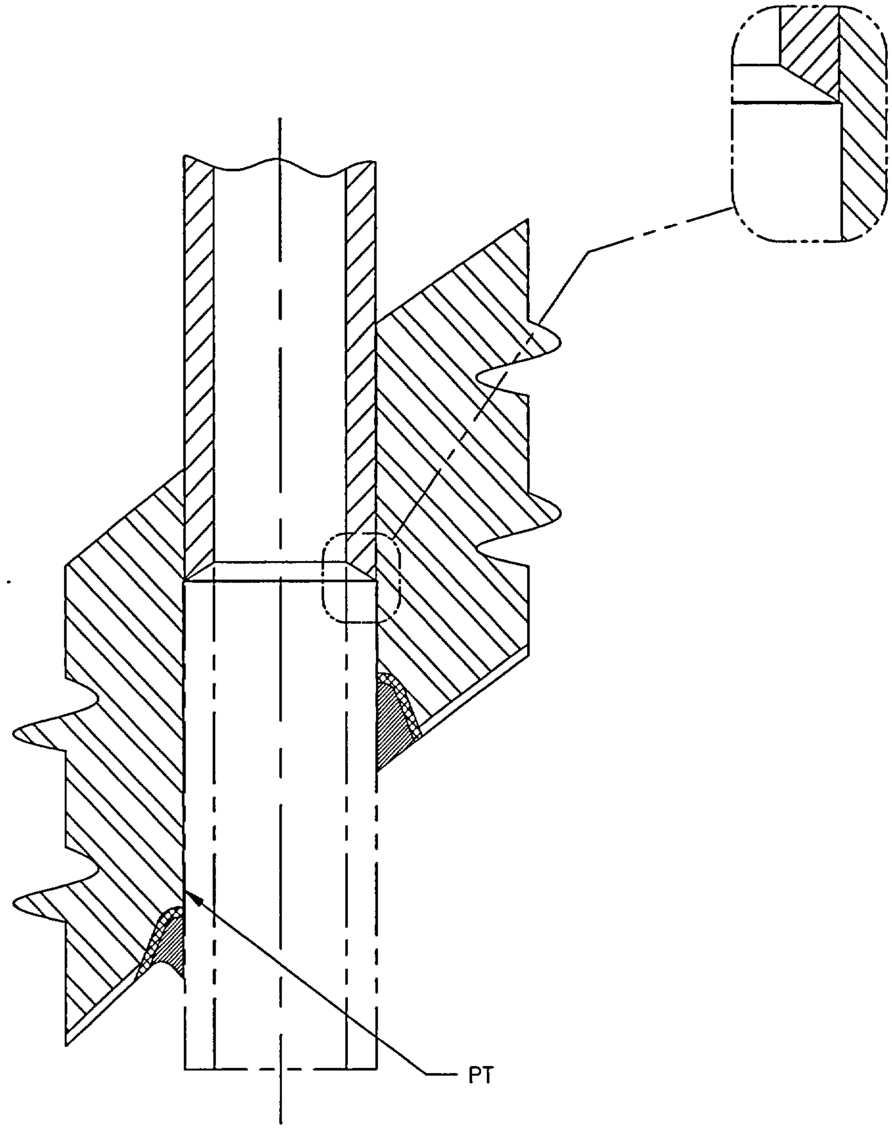


**Figure 3:
New PBNP1 CRDM**

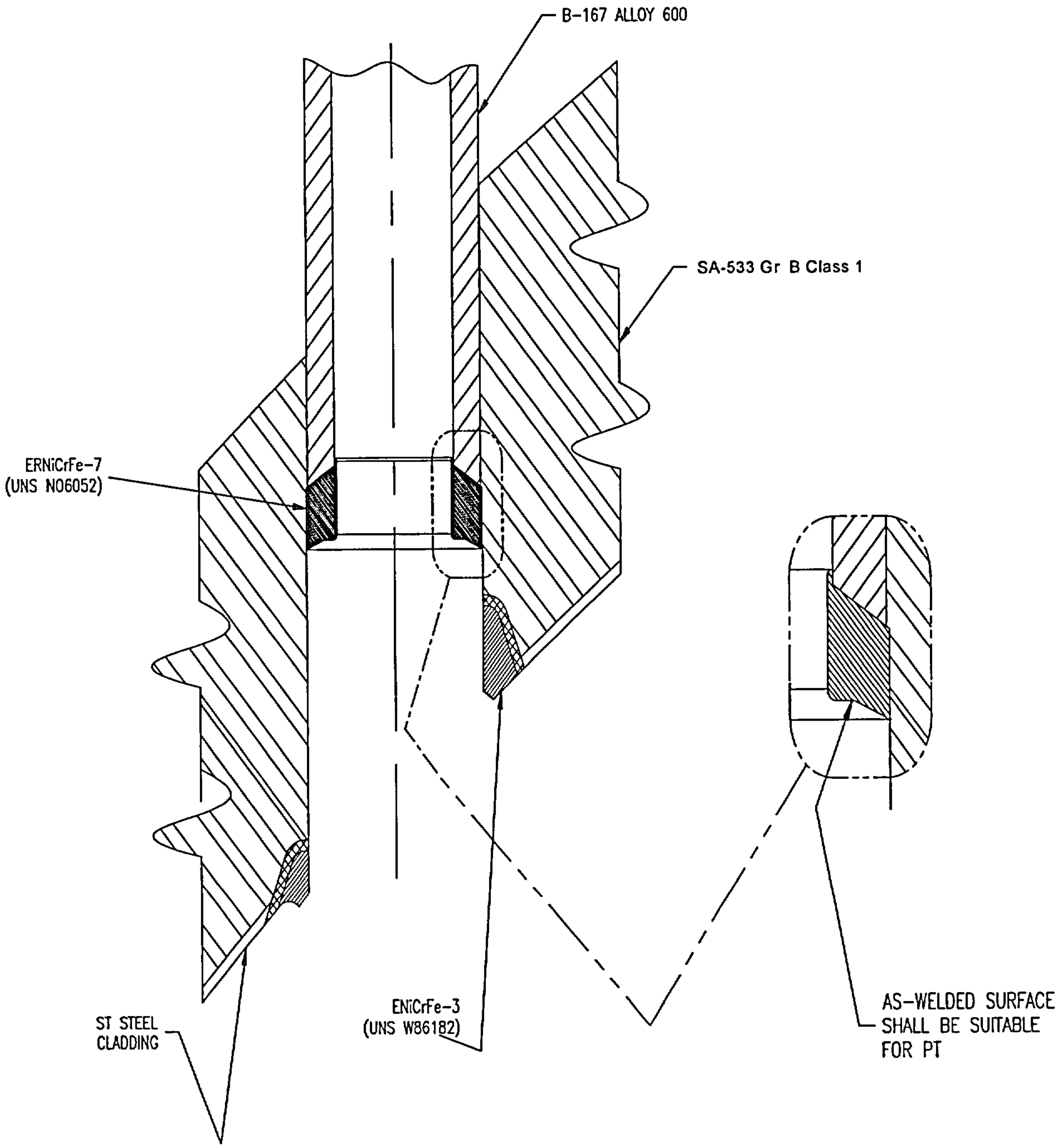


Figure 4:
New PBNP1 CRDM Pressure Boundary Weld

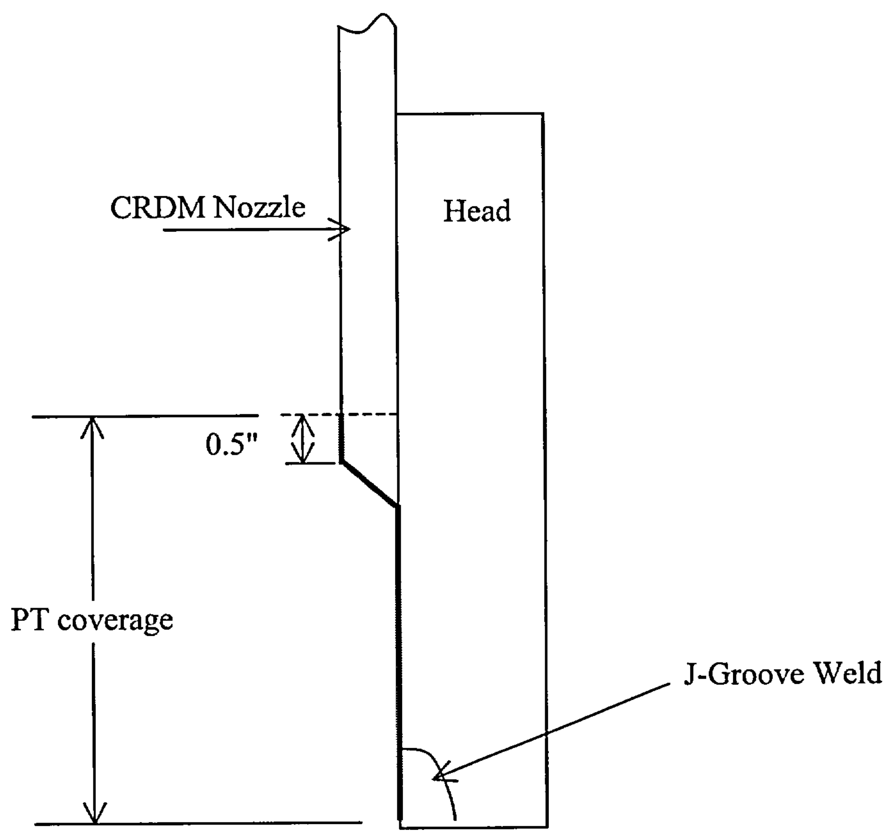


Figure 5:
PBNP1 CRDM Temper Bead Weld Repair,
PT Coverage Prior to Welding

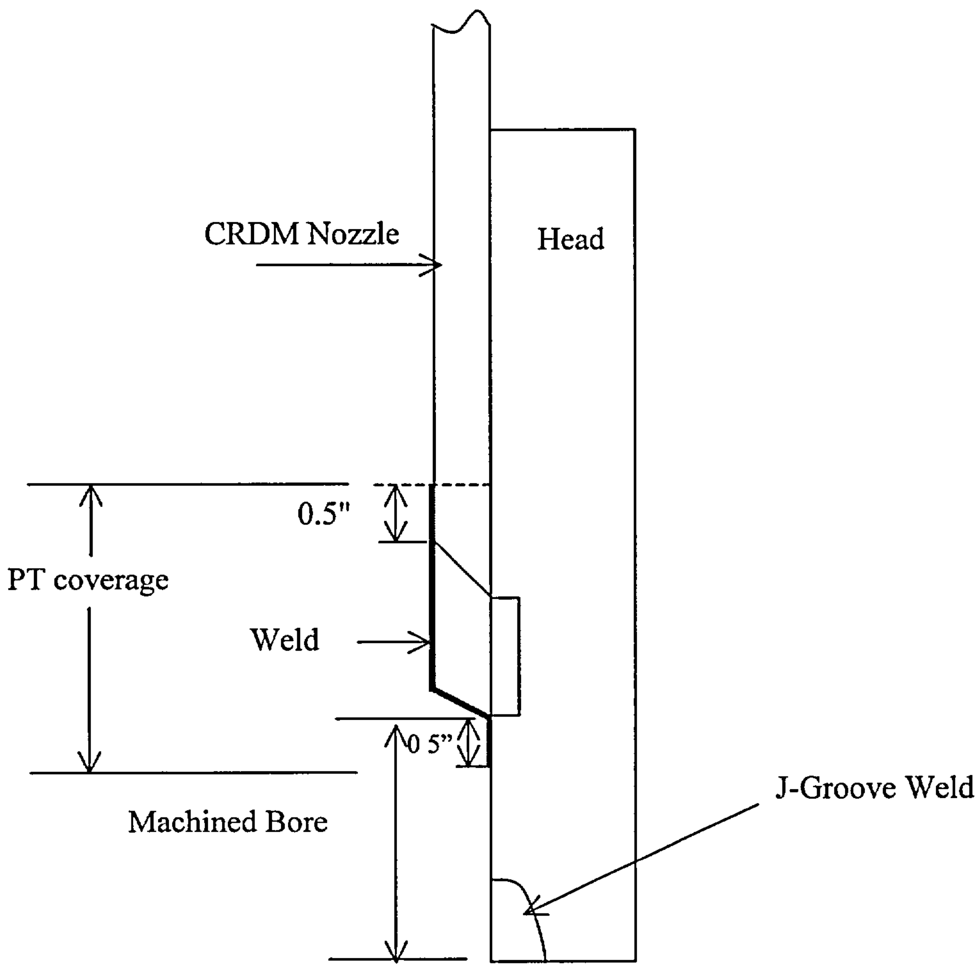


Figure 6:
PBNP1 CRDM Temper Bead Weld Repair,
PT Coverage after Welding

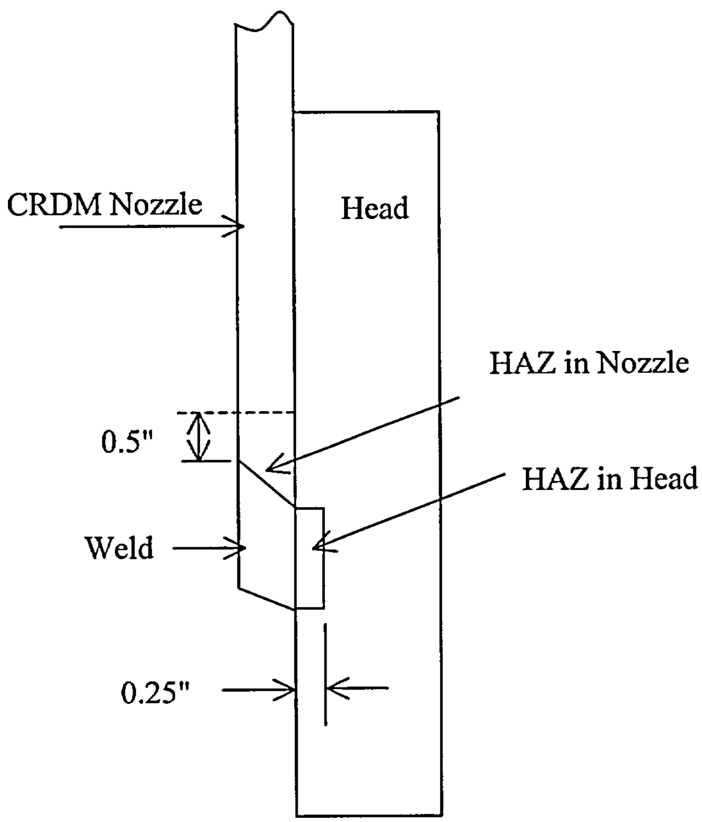


Figure 7:
PBNP1 CRDM Temper Bead Weld Repair
Areas to be Examined

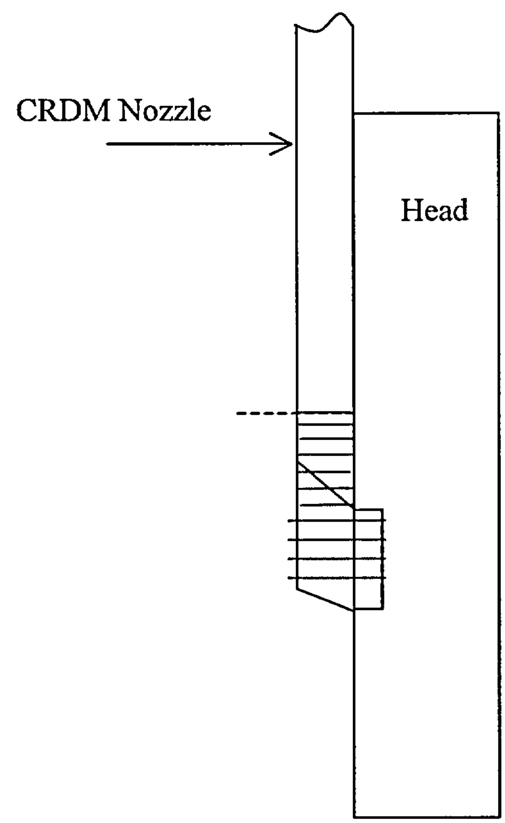


Figure 8
PBNP1 CRDM Temper Bead Weld Repair,
UT 0 degree and 45L Beam Coverage
Looking Clockwise and Counter-Clockwise

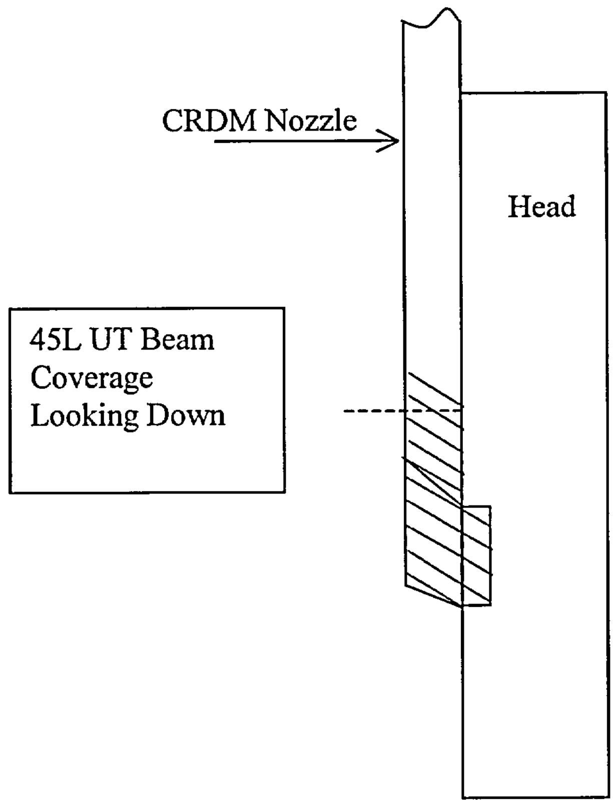


**Figure 9:
PBNP1CRDM Temper Bead Weld Repair,
45L UT Beam Coverage Looking Down**

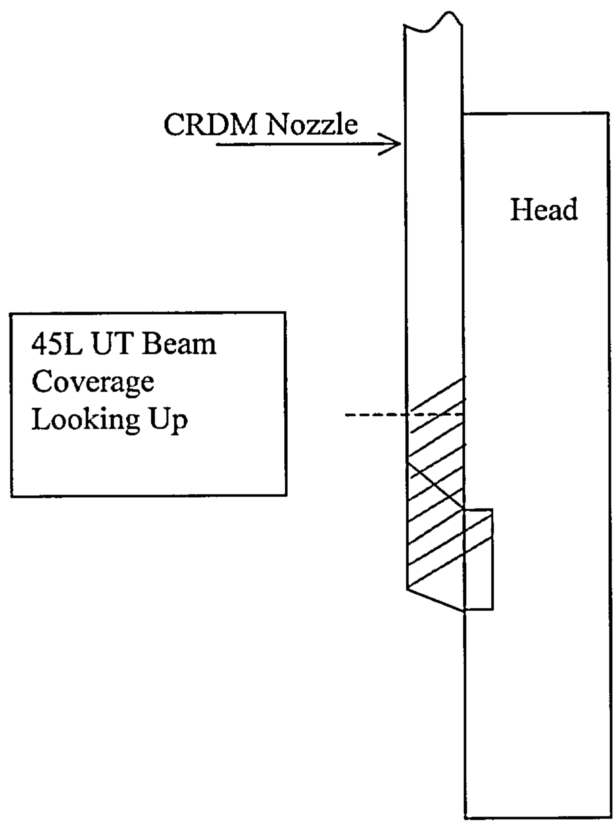


Figure 10:
PBNP1 CRDM Temper Bead Weld Repair,
45L UT Beam Coverage Looking Up

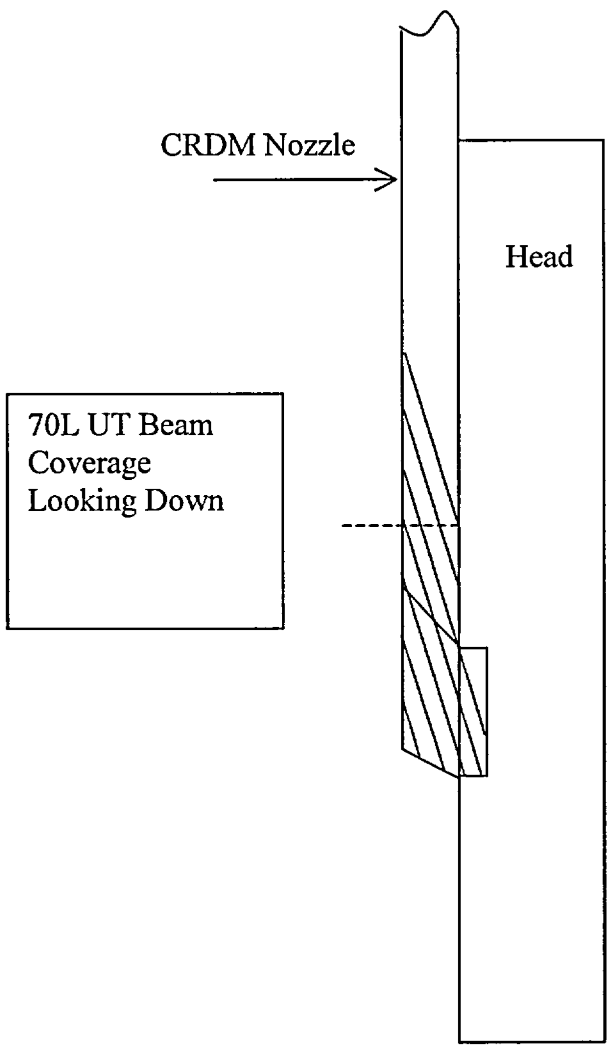


Figure 11:
PBNP1 CRDM Temper Bead Weld Repair, 70L UT Beam Coverage Looking Down

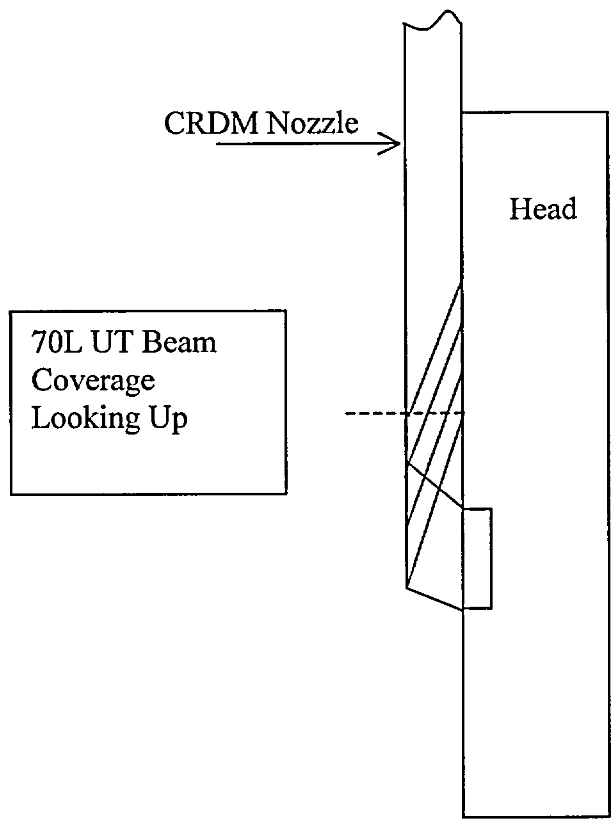


Figure 12:
PBNP1 CRDM Temper Bead Weld Repair, 70L UT Beam Coverage Looking Up

Attachment 2
To the Letter

From:

T. J. Webb (NMC)

To:

US NRC Document Control Desk

Dated:

August 28, 2002

Reactor Vessel Closure Head Penetration Repair
Relief Request MR 02-018-2
Point Beach Nuclear Plant Unit 1

POINT BEACH NUCLEAR PLANT
REACTOR VESSEL CLOSURE HEAD PENETRATION REPAIR
RELIEF REQUEST MR 02-018-2

Relief Request No. MR 02-018-2, Characterization of Remaining Flaws – Reactor Vessel Closure Head Penetration Repair

Pursuant to 10 CFR 50.55a(g)(5)(iii), NMC requests relief from ASME XI IWA-3300(b), IWB-3142.4 and IWB-3420, which would require characterization of a flaw existing in the remnant of the J-groove weld that will be left on the Point Beach Unit 1 Reactor Vessel Closure Head (RVCH) if a Control Rod Drive (CRDM) nozzle must be partially removed.
The CRDM nozzle repair configuration is illustrated in Figures 1 and 2.

IDENTIFICATION

Point Beach Unit 1
RVCH Penetrations, Class A (Class 1)

CODE REQUIREMENT

Point Beach Unit 1 is currently in the fourth inspection interval using the 1998 Edition of ASME Section XI with all addenda through 2000. IWB-2500, Examination Category B-P, "All Pressure Retaining Components," Item B15.10, is applicable to the inservice examination of the RVCH to penetration welds. IWA-3300, IWB-3142.4, IWB-3420, are applicable to any flaws discovered during inservice inspection. Specifically:

1. Subarticle IWA-3300(b) contains a requirement for flaws characterization.

2. Sub-subparagraph IWB-3142.4 allows for analytical evaluation to demonstrate that a component is acceptable for continued service. It also requires that components found acceptable for continued service by analytical evaluation be subsequently examined in accordance with IWB-2420(b) and (c).

3. Paragraph IWB-3420 requires the characterization of flaws in accordance with the rules of IWA-3300.

The Construction Code for the Point Beach Unit 1 RVCH is ASME Section III, 1965 Edition.

RELIEF REQUESTED

NMC requests relief from ASME XI IWA-3300(b), IWB-3142.4 and IWB-3420, which would require characterization of a flaw existing in the remnant of the J-groove weld that will be left on the Point Beach Unit 1 RVCH if a CRDM nozzle must be partially removed.

BASIS FOR RELIEF

If inspection of the RVCH CRDM nozzle penetrations reveals flaws affecting the J-groove attachment welds, it may be impractical to characterize these flaws by NDE and it may be impractical to perform any successive examinations of these flaws. The original CRDM nozzle to RVCH weld configuration is extremely difficult to UT due to the compound curvature and fillet radius as can be seen in Figures 1 and 2. The configuration is not conducive to UT due to the configuration and dissimilar metal interface between the NiCrFe weld and the low alloy steel RVCH. Furthermore, due to limited accessibility from the RVCH outer surface and the proximity of adjacent nozzle penetrations, it is impractical to scan from this surface on the RVCH base material to detect flaws in the vicinity of the original weld. These conditions preclude ultrasonic coupling and control of the sound beam in order to perform flaw sizing with reasonable confidence in the measured flaw dimension. Therefore it is impractical, and presently, the technology does not exist, to characterize flaw geometries that may exist therein.

ALTERNATIVE DOCUMENTATION AND REQUIREMENTS

The alternative requirements are:

1. Subarticle IWA-3300(b) contains a requirement for flaw characterization. In lieu of this requirement, a conservative worst-case flaw shall be assumed to exist in this weld that extends from the surface the weld to RVCH low alloy steel base material interface. Fatigue crack growth analysis will be performed based on that flaw to establish the minimum remaining service life of the RVCH.

2. Subparagraph IWB-3142.4 allows for analytical evaluation to demonstrate that a component is acceptable for continued service. It also requires that components found acceptable for continued service by analytical evaluation be subject to successive examination. However, because of the impracticality of performing any subsequent inspection that would be able to characterize any remaining flaw, successive examination will not be performed during the evaluated service time period. Re-examination of the affected CRDM penetration(s) will occur prior to exceeding the remaining service life corresponding to a postulated worst-case flaw.

3. Paragraph IWB-3420 requires the characterization of flaws in accordance with the rules of IWA-3300. As previously stated, a conservative worst-case flaw shall be assumed to exist and appropriate fatigue crack growth analysis will be performed based on that flaw.

JUSTIFICATION OF RELIEF

It will be assumed, for analysis purposes, that a flaw(s) may exist in this weld that extends from the surface of the weld to the RVCH low alloy steel base material interface. Based on extensive industry experience and Framatome ANP direct experience, there are no known cases where flaws initiating in an Alloy 82/182 weld have propagated into the ferritic base material due to primary water stress corrosion cracking (PWSCC).

The worst-case assumption on flaw size will be based on maximum crack growth by PWSCC. Although a crack propagating through the J-groove weld by PWSCC would eventually grow to the low alloy steel RVCH, continued growth by PWSCC into the low alloy steel is not expected to occur. Stress corrosion cracking (SCC) of carbon and low alloy steels is not a problem under BWR or PWR conditions. SCC of steels containing up to 5% chromium is most frequently observed in caustic and nitrate solutions and in media containing hydrogen sulfide. Based on this information, SCC is not expected to be a concern for low alloy steel exposed to primary water. Instead, an interdendritic crack propagating from the J-groove weld area is expected to blunt and cease propagation. This has been shown to be the case for interdendritic SCC of stainless steel cladding cracks in charging pumps and by recent events with PWSCC of Alloy 600 weld materials at ONS-1 and VC Summer.

The surface examinations performed associated with flaw removal during recent repairs at Oconee 1 and 3 on closure head CRDM penetrations, Catawba 2 steam generator channel head drain connection penetration, ANO-1 hot leg level tap penetrations, and the VC Summer Hot Leg pipe to primary outlet nozzle repair all support the assumption that the flaws would blunt at the interface of the NiCrFe weld to ferritic base material.

It will be shown to be acceptable to leave the postulated cracks in the original NiCrFe housing nozzle penetration J-prep buttering, or in the original NiCrFe CRDM housing nozzle to RVCH attachment weld. The evaluations performed in support of this relief will provide an acceptable level of quality and safety without performing flaw characterization required in ASME Section XI 1998 Edition, 2000 Addenda, IWA-3300, IWB-3142.4 and IWB-3420. ASME Section XI flaw evaluations in accordance with IWB-3610 will be performed to show the flaws are acceptable for a number of years. The only driving mechanism for growth of the flaw is fatigue crack growth. The evaluation will assume a radial (with respect to the penetration centerline) crack exists with a length equal to the partial penetration weld preparation depth (throat). The depth of the assumed flaw will be based on the amount of the original partial penetration weld width that actually remains attached to the RVCH after repair activities are complete, including some grinding to improve the contour in the area.

In addition, an analysis of the new pressure boundary welds will be performed using a three-dimensional model of a CRDM nozzle located at the most severe hillside orientation. The software program ANSYS (general purpose finite element program that is used industry-wide) will be used for this analysis. Per FRA-ANP internal procedures, the ANSYS computer code is independently verified as executing properly, by the solution of verification problems using ANSYS and then comparison of the results to independently determined values.

The analytical model will include the RVCH, CRDM nozzle, repair weld, and remnant portions of the original Alloy 600 welds. Portions of the new structural weld which overlap the original structural weld will be assumed to be not load carrying. The model will be analyzed for thermal transient conditions as contained in the Point Beach Unit 1 design specifications. The resulting maximum thermal gradients will be applied to the model along with the coincident internal pressure values. The ANSYS program will then calculate the stresses throughout the model (including the repair welds). The stresses will be post-processed by ANSYS routines to categorize stresses consistent with the criteria of the ASME Code.

The calculated stress values will be compared to the ASME Code, Section III, NB-3000 Criteria as applicable for:

Design Conditions
Normal Operating, and Upset Conditions
Emergency Conditions
Faulted Conditions
Testing Conditions

A very conservative Stress Concentration Factor (SCF) of 4.0 will be assumed for the new pressure boundary weld.

A primary stress analysis for design conditions will be performed. A maximum Primary General Membrane Stress Intensity (Pm) will be calculated and shown to be less than the maximum allowed by the ASME Code. This value will actually be for the RVCH low alloy steel base material, but has the minimum margin for primary stress criteria of any portion of the model (including repair weld, CRDM nozzle, or original welds).

The maximum cumulative fatigue usage factor will be calculated for the point at the intersection of the bottom of the repair weld and the penetration bore and the crevice between the CRDM nozzle outside surface and the RVCH bore. Allowable years of future plant operation will be based on the maximum allowed ASME Code usage factor criterion of 1.0. It is anticipated that the limiting location for this value will be the point at the intersection of the bottom of the repair weld and the penetration bore. At the bottom of the crevice between the CRDM nozzle outside surface and the RVCH bore, the calculated fatigue usage factor is not expected to be limiting to the fatigue life of the repair.

Additionally, a fracture mechanics evaluation will be performed to determine if degraded J-groove weld material could be left in the vessel, with no examination to size any flaws that might remain following the repair. Since the hoop stresses in the J-groove weld are generally about two times the axial stress at the same location, the preferential direction for cracking is axial, or radial relative to the nozzle. It will be postulated that a radial crack in the Alloy 182 weld metal would propagate due to PWSCC, through the weld and butter, to the interface with the low alloy steel RVCH. It is fully expected that such a crack would then blunt and arrest at the butter-to-head interface. Ductile crack growth through the Alloy 182 material would tend to relieve the residual stresses in the weld as the crack grew to its final size and blunted. Although residual stresses in the RVCH material are low, it will be assumed that a small flaw could initiate in the low alloy steel material and grow by fatigue. It will be postulated that a small flaw in the

RVCH would combine with a large stress corrosion crack in the weld to form a radial corner flaw that would propagate into the low alloy steel RVCH by fatigue crack growth, under cyclic loading conditions associated with heatup and cooldown, plant loading and unloading, and rapid transients.

Residual stresses will not be included in the flaw evaluations since it will be demonstrated by analysis that these stresses are compressive in the low alloy steel base metal. Any residual stresses that remained in the area of the weld following the boring operation would be relieved by such a deep crack, and therefore need not be considered.

Flaw evaluations will be performed for a postulated radial corner crack on the uphill side of the RVCH penetration, where the stresses are the highest and the radial distance from the inside corner to the low alloy steel base metal (crack depth) is the greatest. Hoop stresses will be used since they are perpendicular to the plane of the crack. Fatigue crack growth, calculated for the remaining operational life, will be small and the final flaw size will be shown to meet the fracture toughness requirements of the ASME Code using an upper shelf value of 200 ksi$\sqrt{in}$ for ferritic materials.

The evaluations discussed above provide an acceptable level of quality and safety without performing flaw characterization as required in 1998 Edition of ASME Section XI with all addenda through 2000, IWA-3300 (b), IWB-3142.4 and IWB-3420.

IMPLEMENTATION SCHEDULE

This relief requested is intended to cover repair activities that may become necessary as a result of RVCH inspection activities occurring during the Unit 1 refueling outage. The PBNP Unit 1 fall 2002 refueling outage is scheduled to start on September 14, 2002. These examinations are currently planned on or near September 19, 2002 with repairs starting on or near September 30, 2002

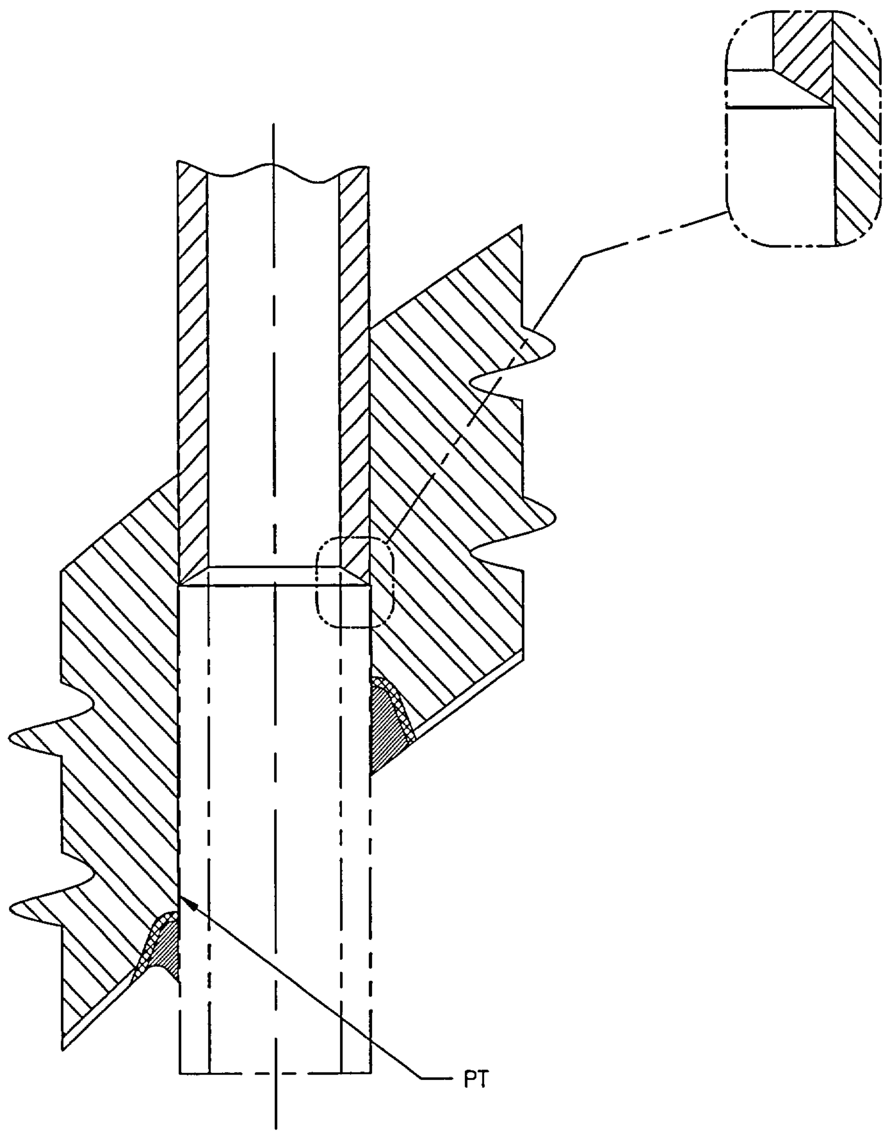


Figure 1
PBNP-1 Penetration Machining

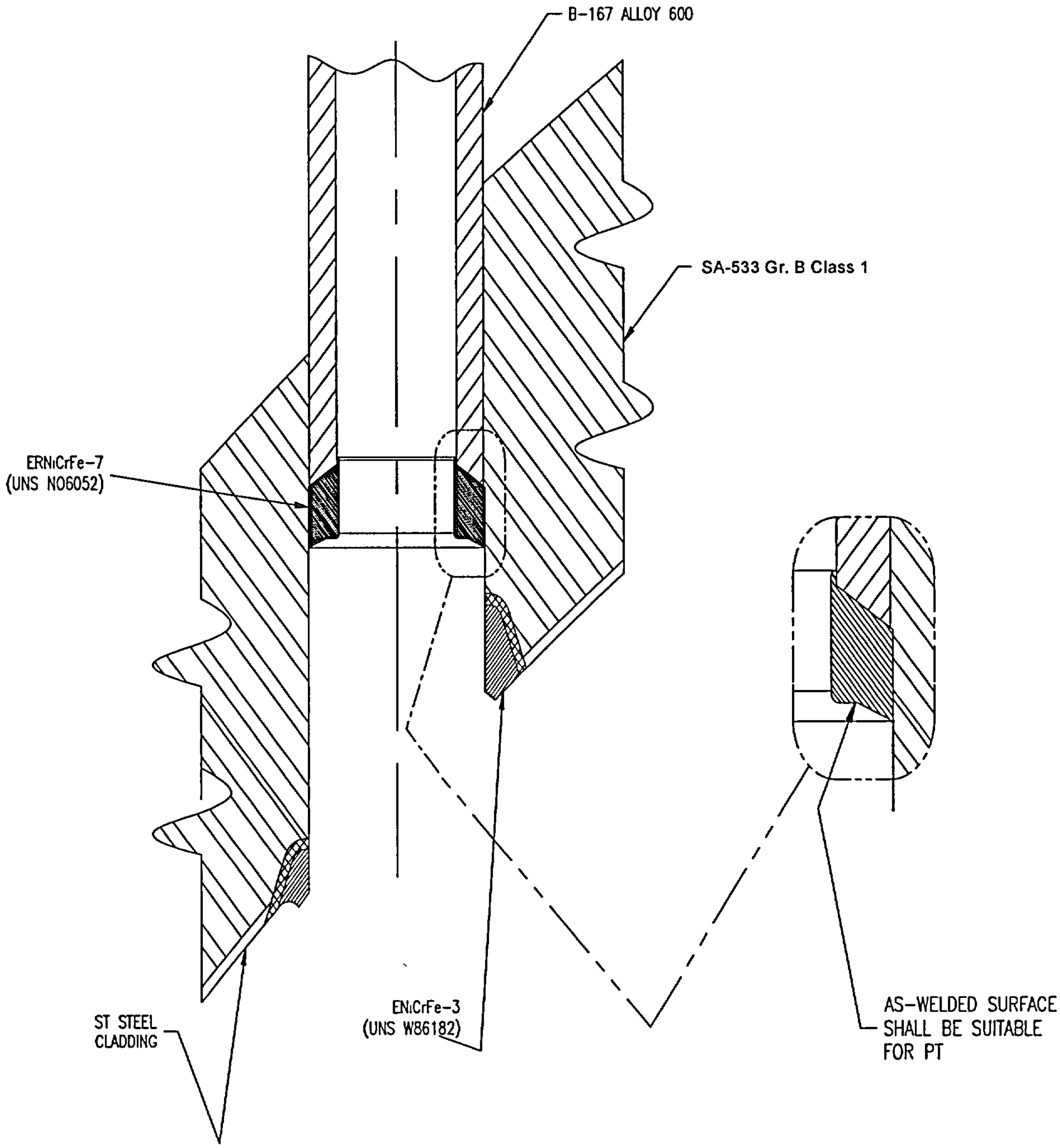


Figure 2
New PBNP-1 CRDM Pressure Boundary Weld

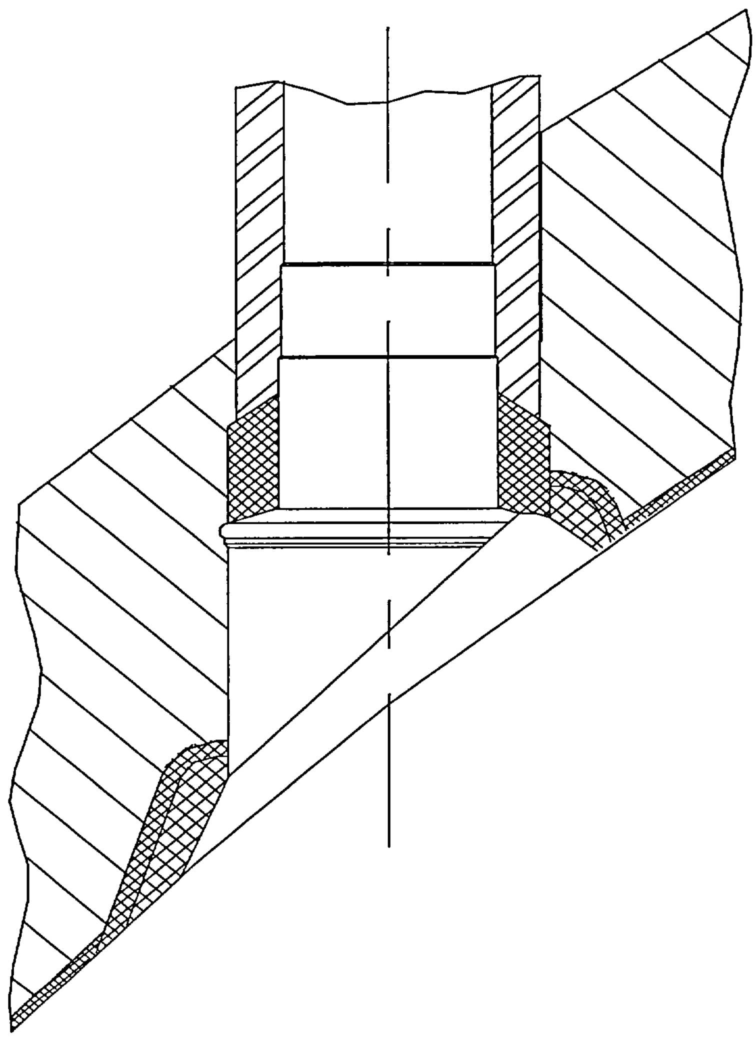


Figure 3
Schematic Illustration of New Repair Configuration
New Structural Weld Which Overlap the Original
Structural Weld