FPL

September 24, 2001
L-2001-214
10 CFR 50.55a

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

Re: Turkey Point Unit 3
Docket No. 50-250
ASME Section XI Relief Request Nos. 28–29,
Associated With Reactor Vessel Closure Head Repair

This letter supercedes FPL's letter L-2001-207, dated September 12, 2001, in its entirety, and FPL hereby withdraws those relief requests, numbered 28-34. During the Turkey Point Unit 3 Cycle 19 refueling outage, planned for October 1, 2001, FPL will be performing effective visual examinations of the Reactor Vessel Closure Head Penetration Nozzles. In the event that these examinations reveal flaws that require repair, FPL is planning to use the methods described in the attached relief requests for repairs.

The repair process will remove the portion of the nozzle that extends below the inner surface of the head. A new weld application surface will be prepared at a point above the heat affected zone of the original pressure boundary weld, within the bore through which the nozzle is installed. A new nozzle-to-head weld will be installed within the head bore by remote machine welding. The original weld is not part of the new pressure boundary weld. The original weld will be left in place at the junction of the head nozzle bore to head inside surface, and analyzed for acceptability.

There are 66 penetrations in the Turkey Point Unit 3 reactor vessel head. Of these, 65 are 4-inch bore diameter, with the same original configuration (the remaining penetration is a 1.050 inch diameter head vent nozzle). As described in FPL's response to NRC Bulletin 2001-01 (documented in FPL letter L-2001-198), of the 65 4-inch bore nozzles: 59 are used for CRDM's (45 active, 6 part length, 8 spare), 2 are used for the reactor vessel level monitoring system, and 4 are used for the core exit thermocouple columns. These 65 nozzles will all be examined, and repaired if necessary, as described herein. For convenience, reference to CRDM nozzles throughout this submittal includes all 65 4-inch bore nozzles.

In order to conduct the repairs efficiently, and to ensure personnel exposure is kept to a minimum, relief from portions of the ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1989 Edition, is requested. Pursuant to 10 CFR 50.55a (a)(3), Florida Power & Light Company (FPL) requests approval of Relief Requests Nos. 28 and 29, attached.

FPL has determined pursuant to 10 CFR 50.55a (a)(3)(ii) that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The repair plan seeks to significantly reduce exposures by instituting machine remote processes for nozzle repair, similar to those used at Oconee Nuclear Station Unit 2 (ONS-2), and planned for use at Three Mile Island Unit 1 and Crystal River Unit 3. Based on the ONS-2 experience of repairing manually versus repairing with machine remote processes, FPL estimates radiological dose savings of greater than 24 Rem for each CRDM nozzle repaired. There are 65 CRDM nozzles on the Unit 3 reactor vessel head. If repairs are necessary, approval of these requests is required in order to realize the above radiological dose savings.

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Approval of these requests will allow repairs to nozzles using alternatives to welding processes and examination requirements of several ASME Code sections for the repair of Class A Reactor Vessel head components. The relief requests have been evaluated, and FPL has determined that the alternatives described in each relief request provide an acceptable level of quality and safety.

Relief Request 28 (Attachment 1), proposes performing the repair with a remotely operated weld tool, using the machine Gas Tungsten-Arc Welding process and the ambient temperature temper bead method, with 50°F minimum preheat temperature and no post weld heat treatment.

It is assumed that flaws will remain in the original nozzle to head weld, which will not be removed. Relief Request 29 (Attachment 2), is seeking relief from the 1989 Edition of ASME Section XI, IWA-3300(b) and IWB-3420, Flaw Characterization. In lieu of fully characterizing the remaining cracks, FPL proposes, in the relief request, to utilize worst-case assumptions to conservatively estimate the crack extent and orientation.

We request approval of these reliefs by October 6, 2001, to support the Turkey Point Unit 3 refueling outage. Please contact John Manso at (305) 246-6622, if there are any questions about this submittal.

Very truly yours,

John P. McElwain
Vice President
Turkey Point Plant

CLM

Attachments

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant
Florida Department of Health and Rehabilitative Services

RELIEF REQUEST NO. 28
"WELD REPAIR OF REACTOR VESSEL CLOSURE HEAD PENETRATIONS"

I. COMPONENT IDENTIFICATION:

Turkey Point Unit 3
Reactor Vessel Closure Head (RVCH) Penetrations, Class 1
FPL Drawing No. 5610-M-400-57 Rev. 1

II. CODE REQUIREMENT:

Rules for Inservice Inspection of Nuclear Power Plant Components, Section XI, 1989 Edition, Examination Category B-O, "Pressure Retaining Welds in Control Rod Housings," code item B14.10.

III. RELIEF REQUESTED:

Pursuant to 10 CFR 50.55a (a)(3)(i), FPL requests relief to use an ambient temperature temper bead method of repair as an alternative to the requirements of ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1989 Edition.

FPL is proposing to perform the repair with a remotely operated weld tool, using the machine Gas Tungsten-Arc Welding (GTAW) process and the ambient temperature temper bead method, with 50 °F minimum preheat temperature and no post weld heat treatment.

IV. WELD REPAIR METHOD:

FPL plans to perform CRDM nozzle penetration repairs by welding the RPV head (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.

(f) Peening will not be used, however, the weldment final surface will be abrasive water jet conditioned.

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 of the same P-Number and Group Number as the materials to be welded. The materials shall be post weld 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 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.

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 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.

4.0 Examination

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

(b) The final weld surface and the band around the area defined in Paragraph 1.0(d) 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.

(c) NDE personnel will be qualified in accordance with IWA-2300.

(d) Surface examination acceptance criteria will be in accordance with NB-5350. Ultrasonic examination acceptance criteria will be in accordance with NB-5330. Code Case N416-1 (approved as shown in Reg. Guide 1.147) allows the use of ASME III, 1992 Edition, no Addenda, for all NDE methods and acceptance criteria (as allowed by the 1989 Edition of ASME XI, IWA-4120(c)).

5.0 Documentation

Repairs will be documented on Form NIS-2.

V. JUSTIFICATION FOR USE OF ALTERNATIVE:

This proposed alternative temperbead welding process provides an equivalent acceptable level of quality and safety to the temper bead welding process described in ASME, Section XI 1989. The repair process, technical justification, and occupational exposure savings are described below:.

Repair Process

a) Visual inspections for leakage/boric acid deposits of CRDM nozzle penetrations will be conducted during the Turkey Point Unit 3 Cycle 19 refueling outage.
b) CRDM nozzles that are determined to have through-wall leakage will be repaired. Remote machine repair processes are planned.
c) Nondestructive examinations using ultrasonic methods are planned for the base metal of the nozzles determined to have through-wall leakage.
d) The thermal sleeves will be removed by remote machining.
e) Using a remote tool from below the RVCH, each of the leaking nozzles will first receive a roll expansion into the RVCH base material to insure that the nozzle will not move during the repair operations.
f) A semi-automated machining tool operating underneath the RVCH will remove the entire lower portion of the CRDM nozzle to a depth above the existing J-groove partial penetration weld. The machining tool will also perform the CRDM nozzle repair weld preparation. The operation will sever the existing J-groove partial penetration weld from the CRDM nozzles.
g) The machined surface will be cleaned, and then examined using liquid penetrant (PT).
h) The repair weld will be performed with a remotely operated machine GTAW weld head, using the ambient temperature temper bead process to install the new ERNiCrFe-7 (Alloy 52) pressure boundary weld between the shortened nozzle and the inside bore of the RVCH base material, with 50 °F minimum preheat temperature.
i) The final weld face, not including the taper transition, will be machined.

j) The final weld will be liquid penetrant and ultrasonically examined prior to the abrasive water jet conditioning, to preclude masking by the water jet process.
k) The final inside diameter surface of the CRDM nozzle near the new weld and the new weld will then be conditioned by abrasive water-jet conditioning to create a final surface that is in compression, to produce optimum resistance to primary water stress corrosion cracking.

The CRDM nozzle repair configuration described above is illustrated in Figures 3 and 4.

Technical Justification:

Quality temper bead welds, without preheat and postheat, can be made based on welding procedure qualification test data derived from machine GTAW ambient temperature temper bead welding process. The proposed alternative repair technique has been demonstrated as an acceptable method for performing reactor pressure vessel repairs. The ambient temperature temper bead technique has been approved by the NRC as having an acceptable level of quality and safety and was successfully used at several sites (Duane Arnold, Nine Mile Point, and Fitzpatrick).

Results of procedure qualification work undertaken to date indicate that the process produces sound and tough welds. For instance, typical tensile test results have been ductile breaks in the weld 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 both absorbed energy and lateral expansion perspectives, compared to the unaffected base material.

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

The absorbed energy, lateral expansion, and percent shear were significantly greater for the HAZ than the unaffected base material at both test temperatures. It is clear from these results that the GTAW temper bead process has the capability of producing acceptable repair welds.

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 affect 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 the Turkey Point Unit 3 RVCH, was used to demonstrate the welding technique described herein. During the mockup, thermocouples were placed to monitor the temperature of the 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.

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.

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. Also, elimination of the band PT will result in reduction in dose to personnel.

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 in reactor pressure vessel head thickness and primary coolant Iron (Fe) release rates, has been evaluated by Framatome-ANP (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 sources. Since Turkey Point has only 65 CRDM nozzles, this estimate is bounding.

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 heat treatment. Additional FRA-ANP qualifications were performed at room temperature with cooling water to limit the maximum interpass temperature to a maximum of 100 °F. The qualifications were performed on the same P-3 Group-3 base material using the same filler material (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. The qualification of the ambient temperature temper bead welding process demonstrates that the proposed alternative provides an acceptable level of quality and safety.

Occupational Exposure:

Recent experience gained from the performance of manual repairs at other plants' CRDM nozzles indicated that more remote automated repair methods were needed to reduce radiation dose to repair personnel and still provide acceptable levels of quality and safety. Since FPL recognizes the importance of ALARA principles, this remote repair method has been developed for the possibility of leaking nozzles at Turkey Point Unit 3.

This approach for repair of leaking CRDM nozzles will significantly reduce radiation dose to repair personnel while still maintaining acceptable levels of quality and safety. The total radiation dose (assuming one nozzle for estimation purposes) for the proposed remote repair method is projected to be approximately 7.5 Rem. In contrast, using manual repair methods for Turkey Point Unit 3 would result in a total radiation dose of approximately 32 Rem.

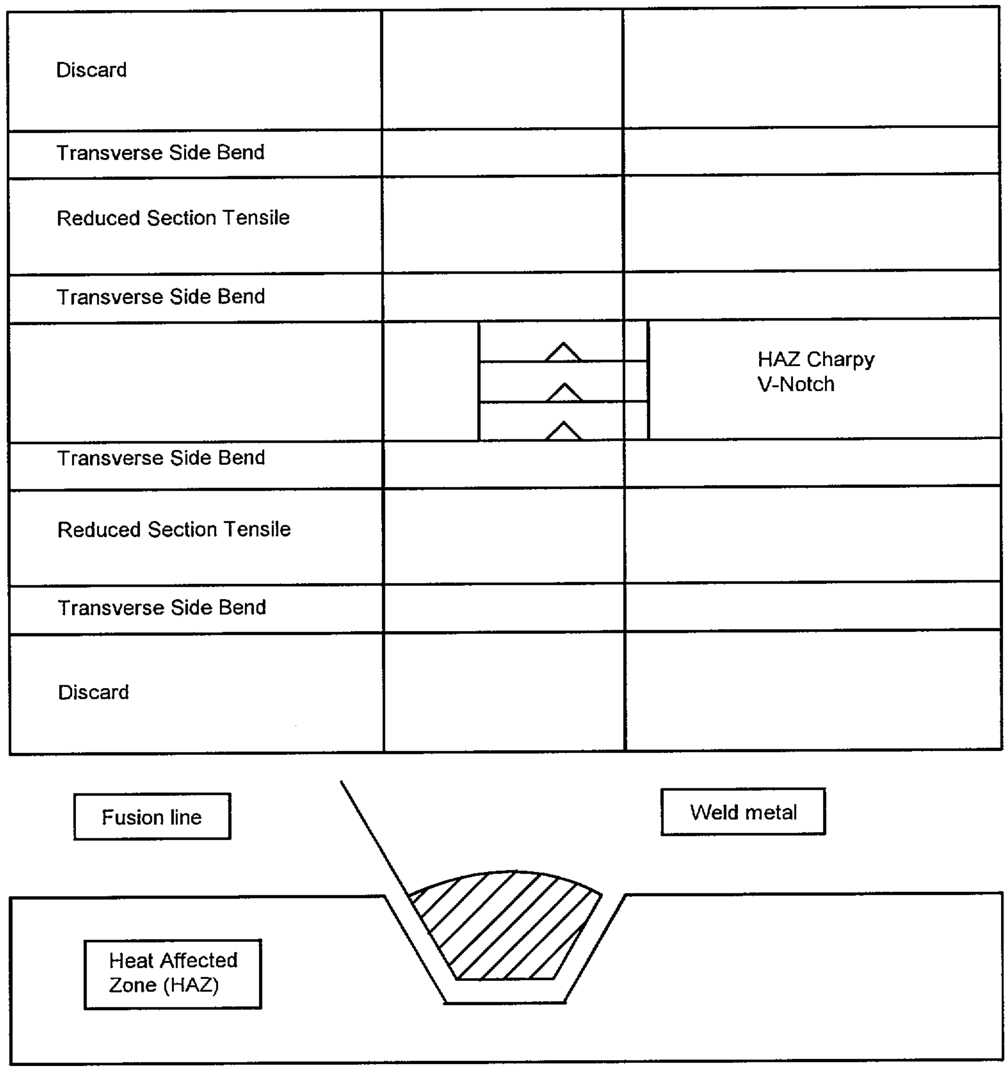
Therefore, based on the discussion above, it has been determined that the proposed alternative provides an acceptable level of quality and safety.

VI. Implementation Schedule:

Unacceptable flaws detected during the Turkey Point Unit 3 Cycle 19 refueling outage (planned for October, 2001) will be repaired prior to plant startup using the machine GTAW Ambient Temperature Temper Bead technique, with a 50 °F minimum preheat and no post weld heat treatment.

Table 1:
PTN-3 CRDM Replacement Weld
UT Search Unit Transducer Characteristics

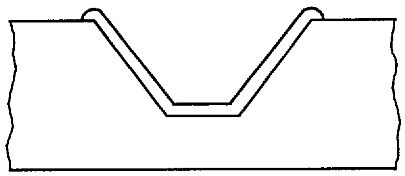
Angle/Mode	Freq.	Model	Mfg.	Size	Focal Depth	Beam Direction
0° L-wave	2.25 MHz	2077	Sigma	.15" x .30"	0.45"	N/A
45° L-wave	2.25 MHz	2118	Sigma	.30" x .20"	0.45"	Axial
70° L-wave	2.25 MHz	2370	Sigma	.72" x .21"	0.69"	Axial
45° L-wave (effective)	2.25 MHz	2117	Sigma	.30" x .20"	0.45"	Circ.



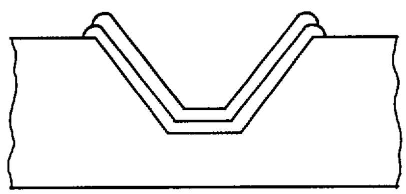
GENERAL NOTE: Base metal Charpy impact specimens are not shown. This figure illustrates a similar-metal weld.

QUALIFICATION TEST PLATE

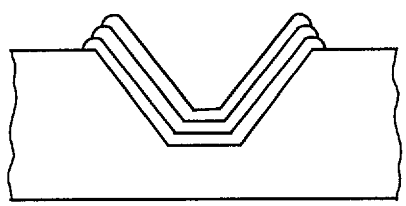
Figure 1



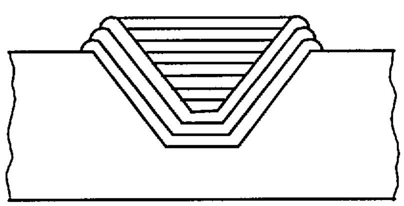
Step 1: Deposit layer one with first layer weld parameters used in qualification.



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

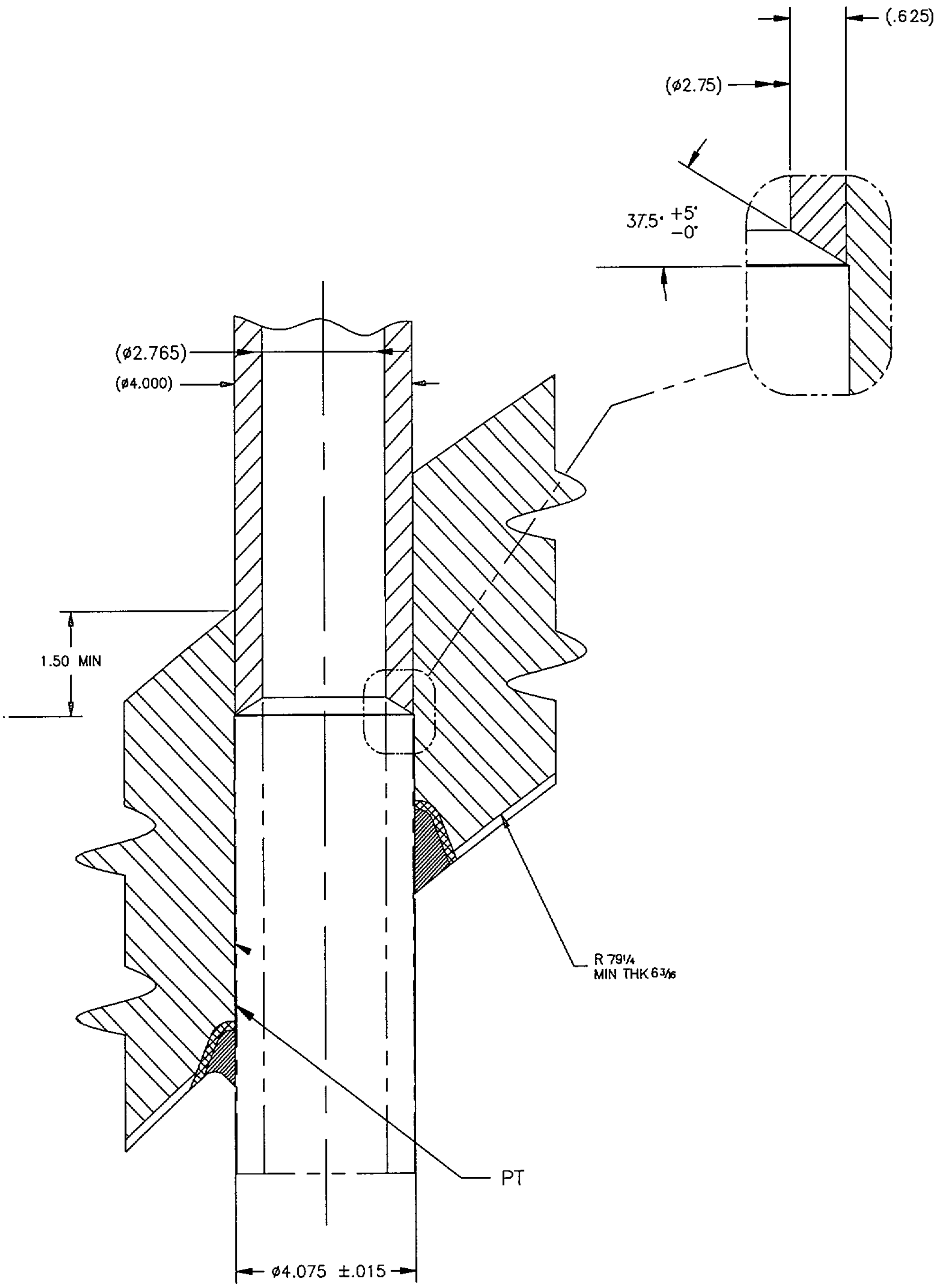


Figure 3
PTN-3 CRDM Machining

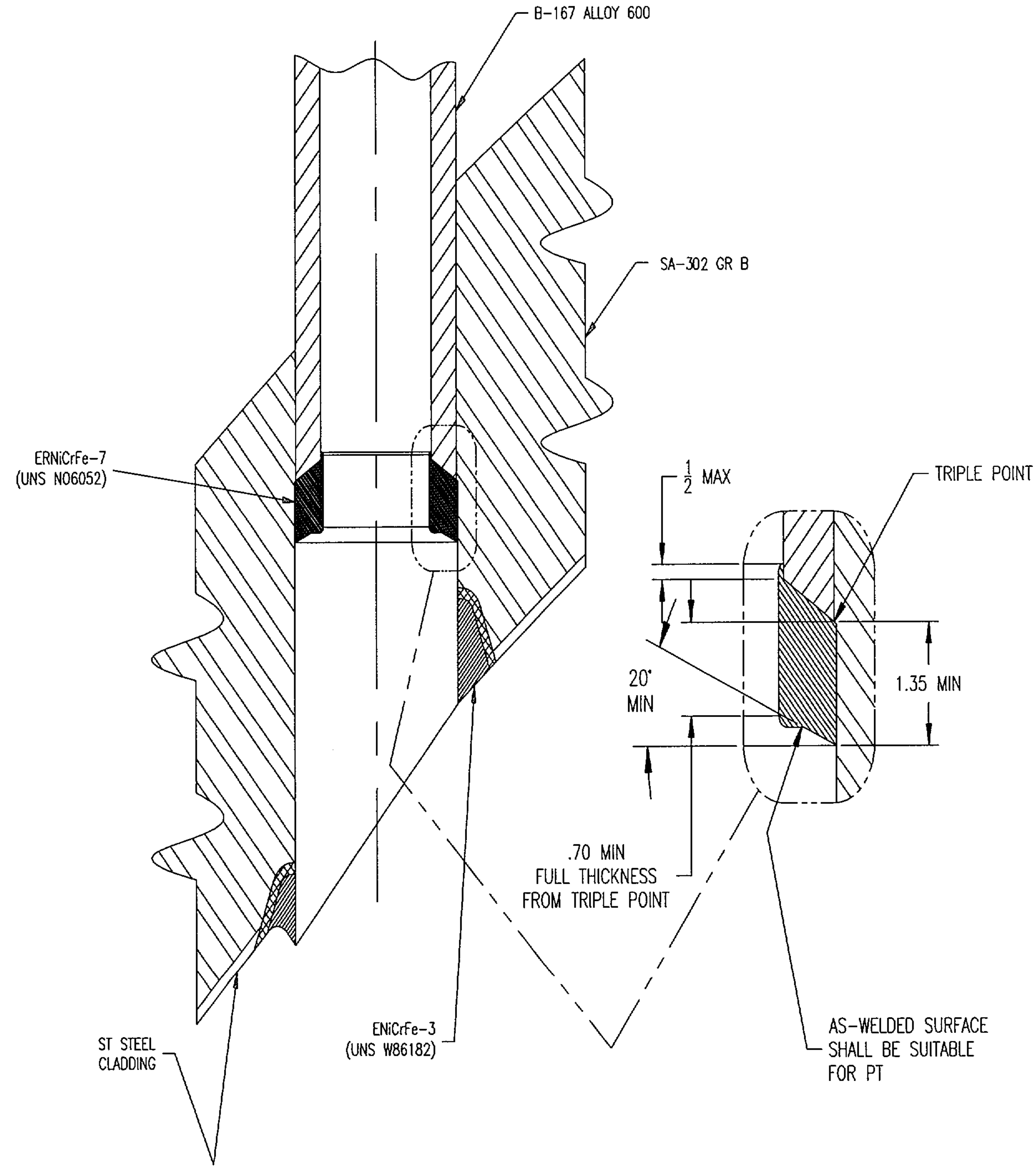


Figure 4:
PTN-3 New CRDM Pressure Boundary Welds

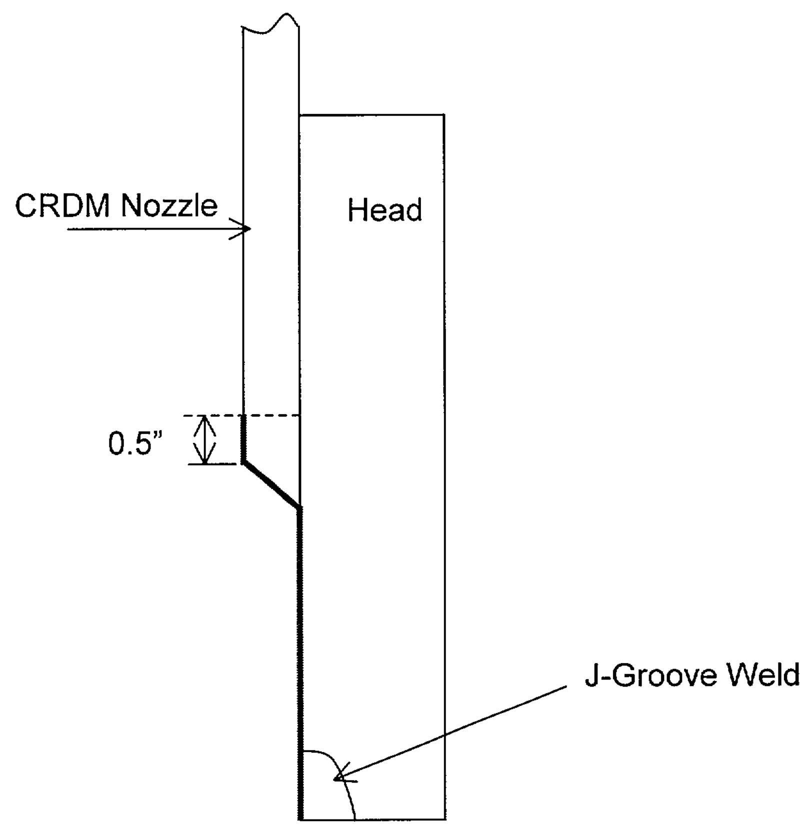


Figure 5:
PTN-3 CRDM Temper-Bead Weld Repair,
PT Coverage Prior to Welding

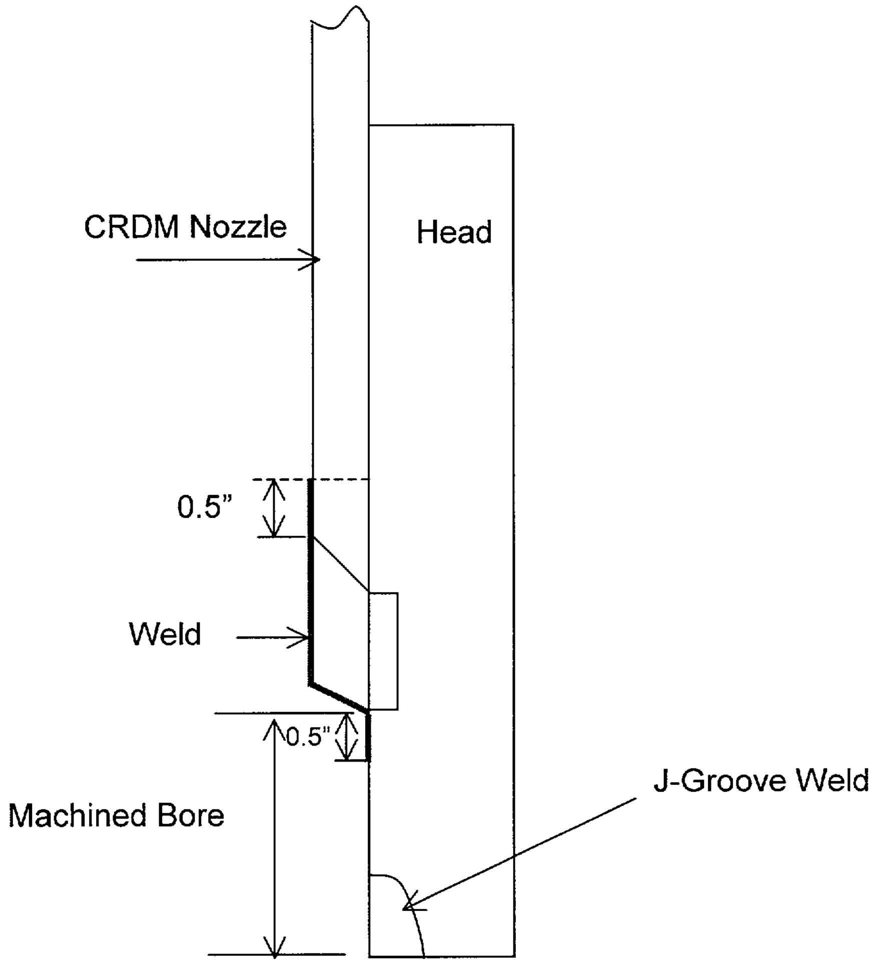


Figure 6:
PTN-3 CRDM Temper-Bead Weld Repair,
PT Coverage After Welding

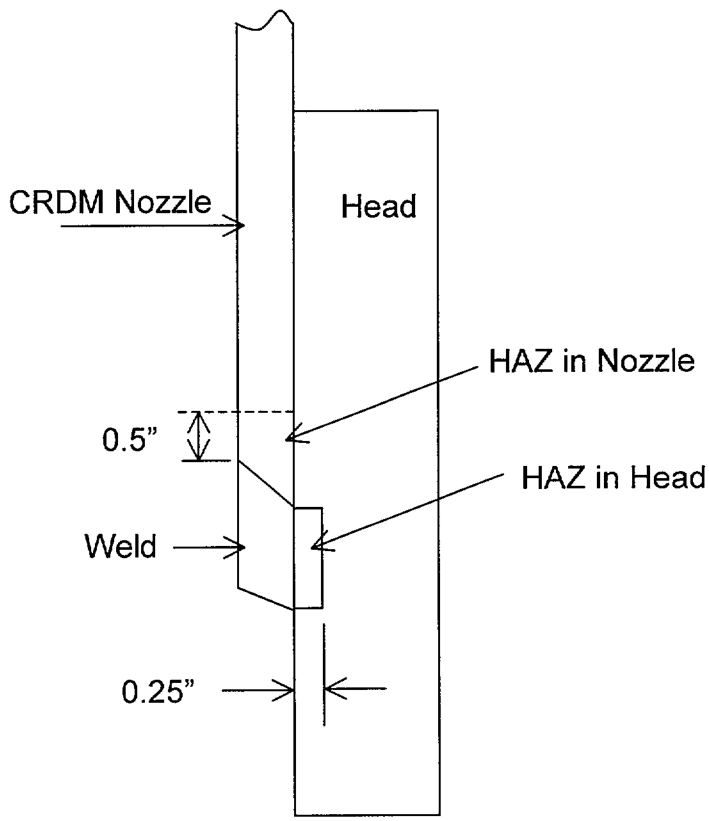


Figure 7:
PTN-3 CRDM Temper-Bead Weld Repair
Areas to be Examined

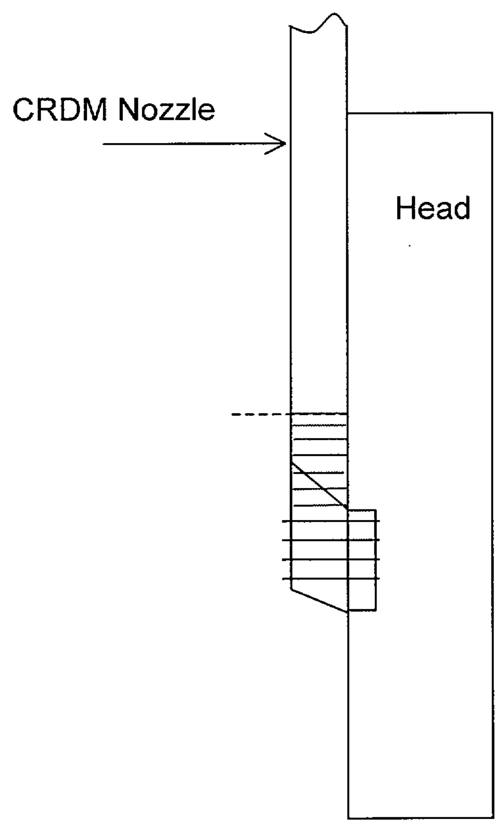


Figure 8:
PTN-3 CRDM Temper-Bead Weld Repair,
UT 0 degree and 45L Beam Coverage
Looking Clockwise and Counter-clockwise

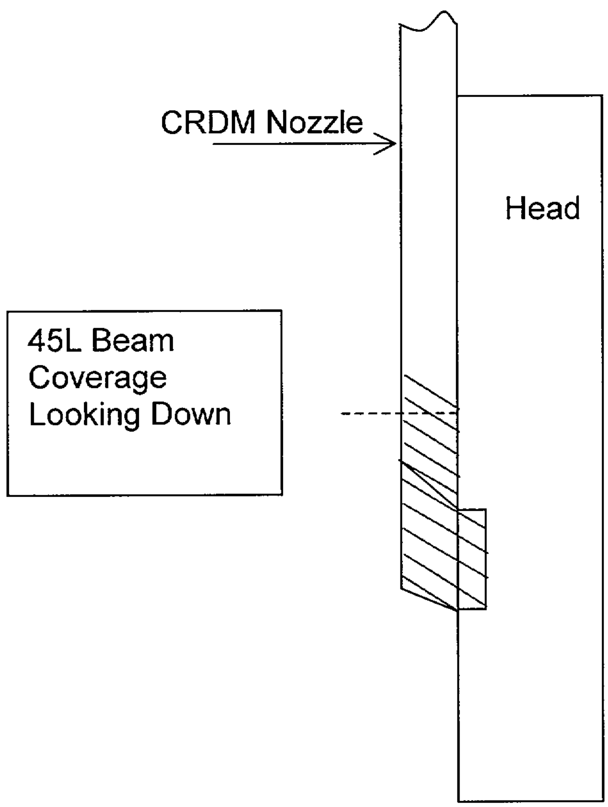


**Figure 9:
PTN-3 CRDM Temper-Bead Weld Repair,
45L UT Beam Coverage Looking Down**

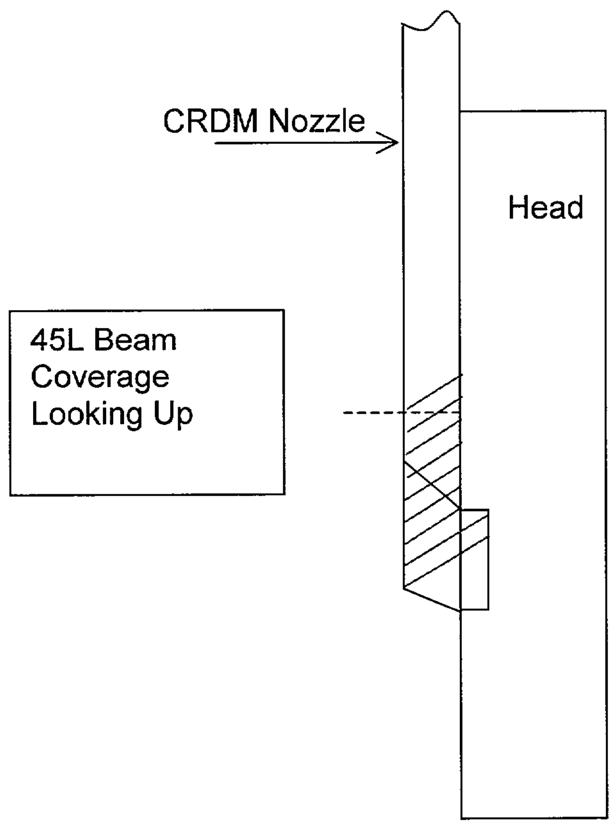


Figure 10:
PTN-3 CRDM Temper-Bead Weld Repair,
45L UT Beam Coverage Looking Up

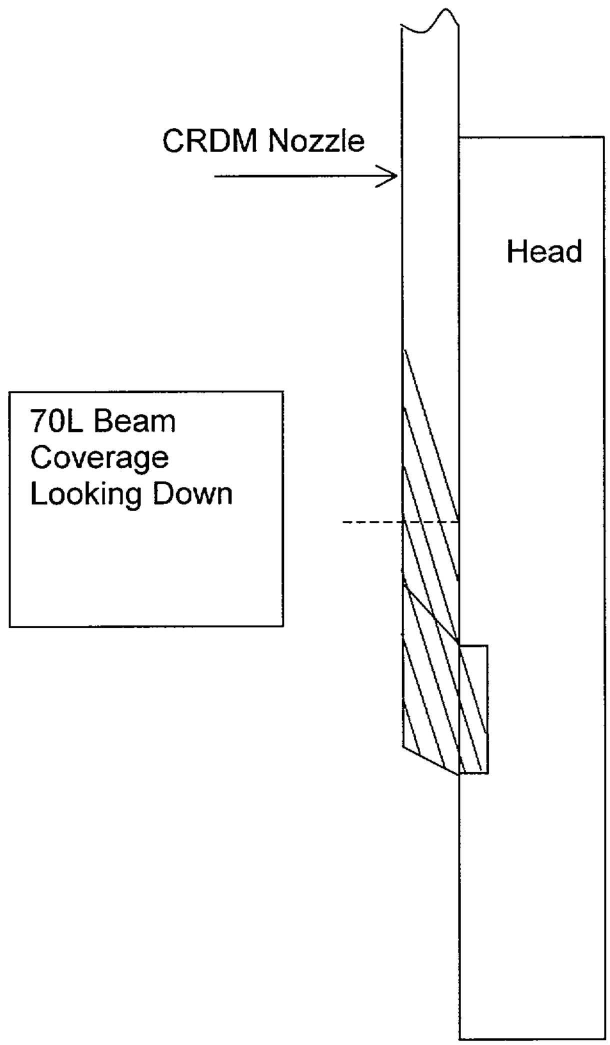


Figure 11:
PTN-3 CRDM Temper-Bead Weld Repair,
70L UT Beam Coverage Looking Down

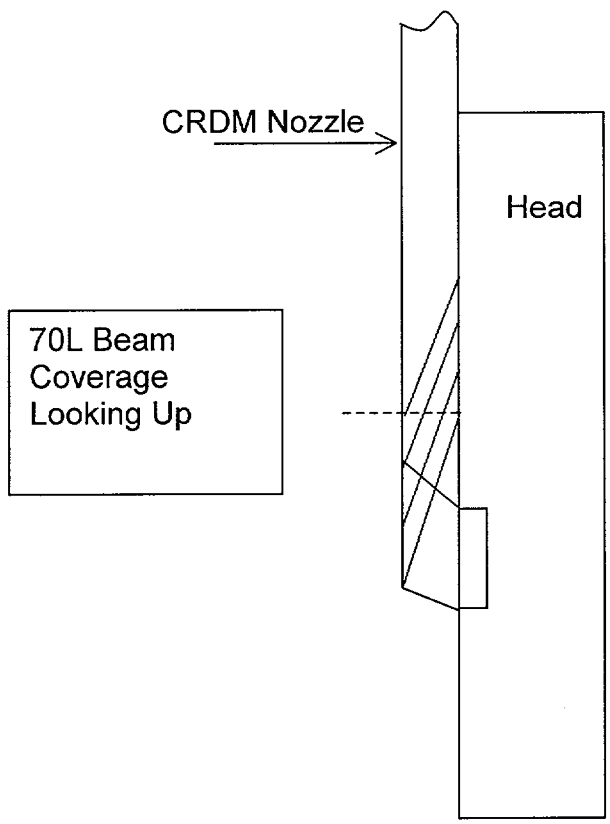


Figure 12:
PTNP-3 CRDM Temper-Bead Weld Repair, 70L UT Beam Coverage Looking Up

Relief Request No. 29
"CHARACTERIZATION OF REMAINING FLAWS"

I. COMPONENT IDENTIFICATION

Turkey Point Unit 3
Reactor Vessel Closure Head (RVCH) Penetrations, Class 1
FPL Drawing No. 5610-M-400-57 Rev. 1

II. CODE REQUIREMENT:

Rules for Inservice Inspection of Nuclear Power Plant Components, Section XI, 1989 Edition, Examination Category B-O, "Pressure Retaining Welds in Control Rod Housings," code item B14.10.

III. RELIEF REQUESTED:

Pursuant to 10 CFR 50.55a (g)(5)(iii), relief is requested from ASME XI IWA-3300 (b) and IWB-3420, which require flaw characterization. Flaws may remain in the original Ni-Cr-Fe housing nozzle penetration J-prep buttering, or in the original Ni-Cr-Fe CRDM housing to RVCH attachment weld. It will be impractical to characterize these flaws by NDE and to show the flaws do not extend into the ferritic head base material.

Except for a chamfer at the corner of the original weld, the original J-groove weld will not be removed. Since it has been determined that cracking in the J-groove weld will most likely accompany a leaking CRDM nozzle, it must be assumed that the "as-left" condition of the remaining J-groove weld includes degraded or cracked weld material.

IV. JUSTIFICATION FOR RELIEF:

The evaluations performed in support of this relief provide an equivalent acceptable level of quality and safety without performing flaw characterization as required in ASME, Section XI 1989, IWA-3300 (b) and IWB-3420. It will be shown to be acceptable to leave the postulated cracks in the original attachment weld and buttering.

ASME Section XI calculations will be performed to show the flaws are acceptable for a number of years. The only driving mechanism is fatigue crack growth, and that would only be driven by heat-up cool-down cycles (6 heatup/cooldown cycles assumed per year). The fracture mechanics evaluation will assume a radial (with respect to the penetration centerline) crack exists with a length equal to the partial penetration weld preparation depth. Based on industry experience and operation stress levels there is no reason for service related cracks to exist in the ferritic material.

The repair process and technical justification are described below:

Repair Process

a) Visual inspections for leakage / boric acid deposits of CRDM nozzle penetrations will be conducted during the Turkey Point Unit 3 Cycle 19 refueling outage
b) CRDM nozzles that are determined to have through-wall leakage will be repaired. Remote machine repair processes are planned.
c) Nondestructive examinations using ultrasonic methods are planned for the base metal of the nozzles determined to have through-wall leakage.
d) The thermal sleeves will be removed by remote machining.
e) Using a remote tool from below the RVCH, each of the leaking nozzles will first receive a roll expansion into the RVCH base material to insure that the nozzle will not move during the repair operations.
f) A semi-automated machining tool operating underneath the RVCH will remove the entire lower portion of the CRDM nozzle to a depth above the existing J-groove partial penetration weld. The machining tool will also form the CRDM nozzle repair weld preparation. The operation will sever the existing J-groove partial penetration weld from the CRDM nozzles.
g) The machined surface will be cleaned, and then subjected to liquid penetrant examination (PT).
h) The repair weld will be performed with a remotely operated machine GTAW weld head using the ambient temperature temper bead process to install the new ERNiCrFe-7 (Alloy 52) pressure boundary weld between the shortened nozzle and the inside bore of the RVCH base material with 50 °F minimum preheat temperature.
i) The final weld face, not including the taper transition, will be machined.
j) The final weld will be liquid penetrant and ultrasonically examined prior to the abrasive water jet conditioning, to preclude masking by the water jet process.
k) The final inside diameter surface of the CRDM nozzle near the new weld and the new weld will then be conditioned by abrasive water-jet conditioning to create a final surface that is in compression, to produce optimum resistance to primary water stress corrosion cracking.

The CRDM nozzle repair configuration described above is illustrated in Figures 1 and 2.

Technical Justification:

An analysis of the new pressure boundary welds will be performed using a 3-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 Reactor Vessel Closure Head, CRDM nozzle, repair weld, and remnant portions of the original Alloy 600 welds. The model is analyzed for thermal transient conditions as contained in the Turkey Point Unit 3 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 are compared to the ASME Code, Section III, NB-3000 criteria 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 = 27.0 ksi. This value will be actually for the RVCH but has the minimum margin for primary stress criteria of any portion of the model (including repair weld, CRDM nozzle, or original welds). The criteria for the primary stresses resulting from the remaining service conditions have greater margin than that shown above.

The maximum cumulative fatigue usage factor will be calculated, and allowable years of future plant operation will be based on the maximum allowed ASME Code usage factor criterion of 1.0. The limiting location for this value is 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 for 40 years of future operation will not be limiting to the fatigue life of the repair.

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 the cyclic loading conditions associated with heatup and cooldown.

Residual stresses will not be included in the flaw evaluations since it was 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 RVCH penetration, where 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 minimal, 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.

Therefore, based on the discussion above, it has been determined that the proposed relief provides an acceptable level of quality and safety.

V. Implementation Schedule:

This relief is scheduled to be implemented if required during the Turkey Point Unit 3 Cycle 19 refueling outage, planned for October, 2001.

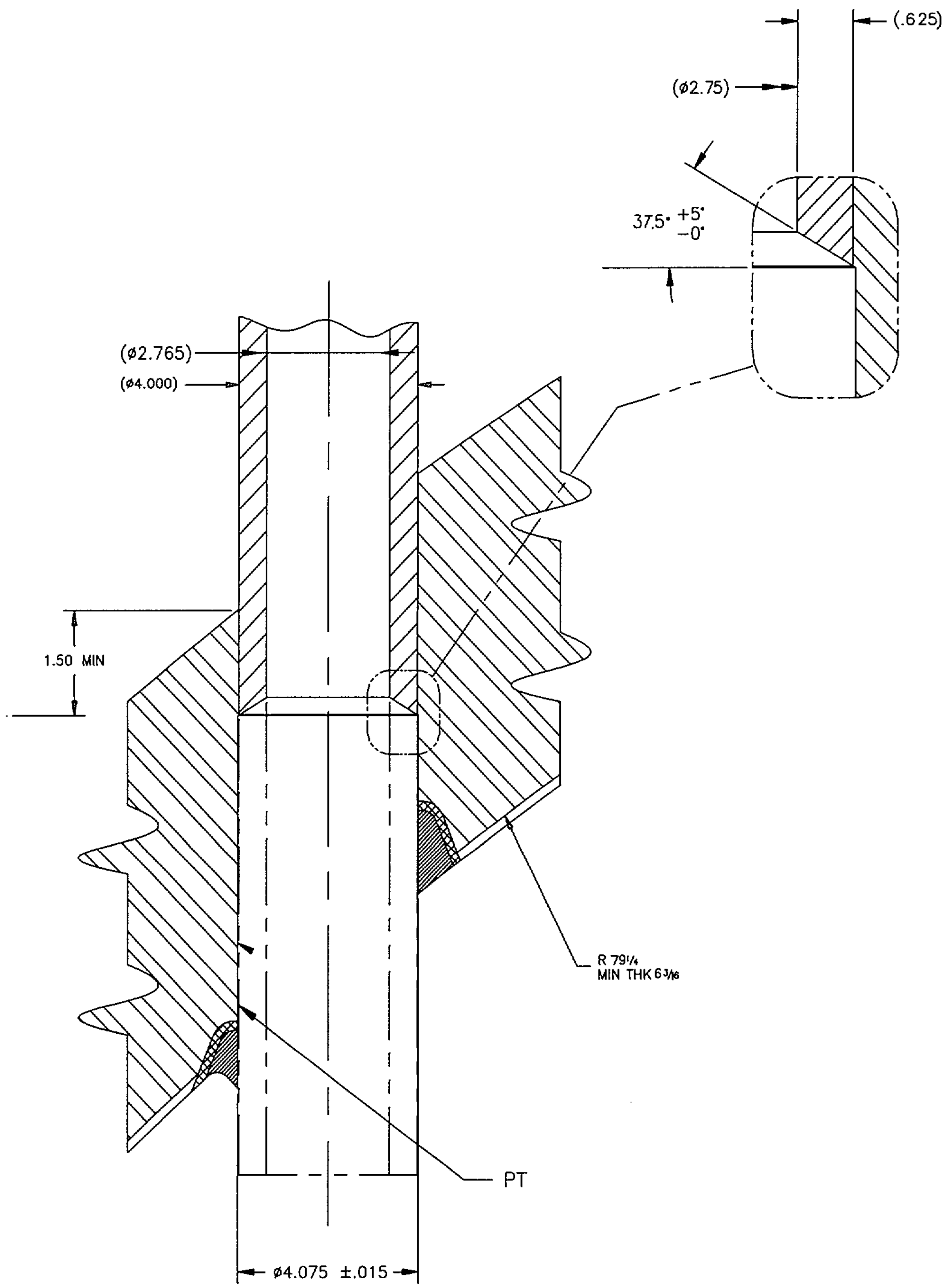


Figure 1:

PTN-3 CRDM Machining

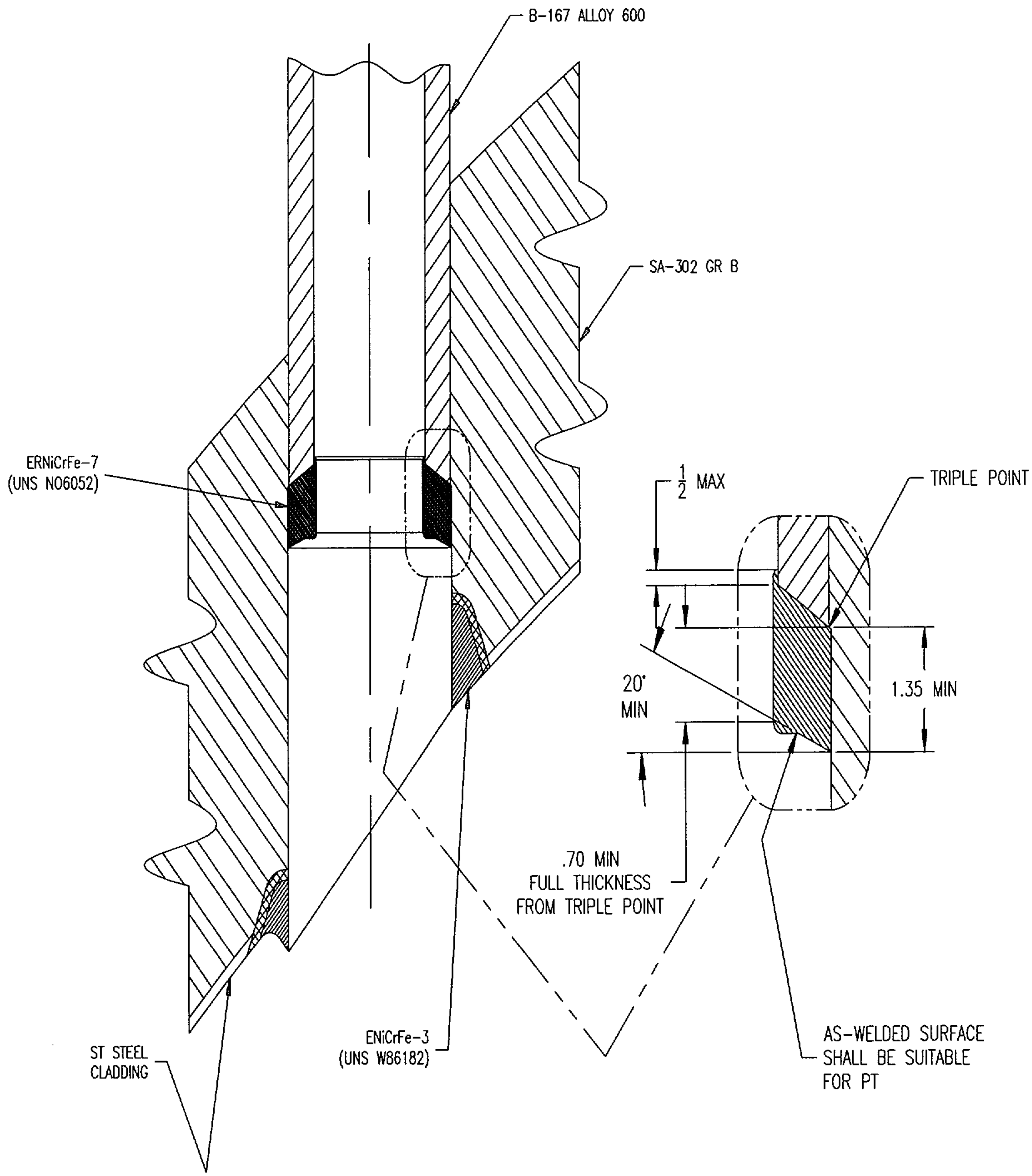


Figure 2:

PTN-3 New CRDM Pressure Boundary Welds