April 25, 2003

Mr. J. A. Stall
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: TURKEY POINT UNITS 3 AND 4 — RELIEF REQUESTS 30 AND 31 ASSOCIATED WITH REACTOR VESSEL CLOSURE HEAD REPAIR (TAC NOS. MB4311 AND MB4312)

Dear Mr. Stall:

By a letter dated March 1, 2002, as supplemented by letters dated June 7, 2002, August 19, 2002, January 30, 2003, and February 21, 2003, Florida Power and Light Company (FPL) submitted Relief Request (RR) 30 for Turkey Point Units 3 and 4 requesting relief from the welding requirements specified in American Society of Mechanical Engineers (ASME) Code, Section XI, paragraph IWA-4120 for contemplated repairs to the reactor pressure vessel (RPV) head control rod drive mechanism (CRDM) nozzle penetrations. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the request proposes an alternative welding method as prescribed in the 1989 Edition of the ASME Boiler and Pressure Vessel Code, Section III.

Additionally, FPL submitted RR 31 for Turkey Point Units 3 and 4 requesting relief from ASME Section XI, 1989 Edition IWA-3100(a). This requires FPL to demonstrate that any flaws discovered during inservice examination of Class 1 of the RPV closure head CRDM nozzle penetrations do not extend into the ferritic head base metal. In accordance with 10 CFR 50.55a(g)(6)(i), the request proposes relief from characterizing flaws through nondestructive examination methods (NDE) that remain in the CRDM J-groove weld after repair due to impracticality. Furthermore, FPL is requesting relief from the successive inspection requirements of these flaws because it remains impractical to characterize the flaws through NDE.

Based on our review of your submittals, we have concluded that the alternative proposed in RR 30 provides an acceptable level of quality and safety and, therefore, it is authorized pursuant to 10 CFR 50.55a(a)(3)(i). For RR 31, we have concluded that it would be impractical to show that the flaws do not extend into the ferritic base metal, and that for successive inspections it would be impractical to characterize the flaws through NDE. Therefore, granting relief for RR 31 pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. The U. S. Nuclear Regulatory Commission staff notes that the relief granted in the enclosed safety evaluation does not relax or supersede any of the requirements issued in Order EA-03-009, nor does it relieve the licensee from any commitments made as result of the Order.

These reliefs are authorized for the remainder of the third 10-year inservice inspection (ISI) interval at Turkey Point Unit 3, which began February 22, 1994, and ends February 21, 2004, and for the remainder of the third 10-year ISI interval at Turkey Point Unit 4, which began April 15, 1994, and ends April 14, 2004.

Sincerely,

***/RA by B.Mozafari Acting for/***

Allen G. Howe, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure: Safety Evaluation

cc w/encl: See next page

These reliefs are authorized for the remainder of the third 10-year inservice inspection (ISI) interval at Turkey Point Unit 3, which began February 22, 1994, and ends February 21, 2004, and for the remainder of the third 10-year ISI interval at Turkey Point Unit 4, which began April 15, 1994, and ends April 14, 2004.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM

RELIEF REQUEST NOS. 30 AND 31

FLORIDA POWER AND LIGHT

TURKEY POINT NUCLEAR PLANT UNITS 3 AND 4

DOCKET NOS. 50-250 AND 251

## 1.0 INTRODUCTION

By a letter dated March 1, 2002, as supplemented by letters dated June 7, 2002, August 19, 2002, January 30, 2003, and February 21, 2003, Florida Power and Light Company (FPL, the licensee) submitted Relief Requests (RRs) 30 and 31. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), RR 30 proposes an alternative welding method as prescribed in the 1989 Edition of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III. In accordance with 10 CFR 50.55a(g)(6)(i), RR 31 proposes relief from characterizing flaws through nondestructive examination (NDE) methods that remain in the control rod drive mechanism (CRDM) J-groove weld after repair due to impracticality. Furthermore, FPL is requesting relief from the successive inspection requirements of these flaws because it remains impractical to characterize the flaws through NDE. The subject RRs are for the remainder of the third 10-year inservice inspection (ISI) interval at Turkey Point Unit 3, which began February 22, 1994, and ends February 21, 2004, and for the remainder of the third 10-year ISI interval at Turkey Point Unit 4, which began April 15, 1994, and ends April 14, 2004.

## 2.0 REGULATORY EVALUATION

The ISI of the ASME Boiler and Pressure Vessel Code (Code) Class 1, Class 2, and Class 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to Section 50.55a(g)(6)(i). As stated, in part, in Section 50.55a(a)(3), alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Enclosure

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The ISI Code of record for Turkey Point Units 3 and 4 third 10-year ISI interval is the 1989 Edition of the ASME Boiler and Pressure Vessel Code.

## 3.0 TECHNICAL EVALUATION

By letter dated March 1, 2002, as supplemented June 7, 2002, August 19, 2002, January 30, 2003, and February 21, 2003, the licensee requested approval to utilize the temper bead repair technique as an alternative to paragraph IWA-4120 (RR 30) and relief from the flaw characterization requirements and successive inspection requirements of IWA-3300 and IWB-2420 (RR 31) for the Reactor Pressure Vessel (RPV) Head-to-CRDM welds.

### 3.1 RELIEF REQUEST NO. 30, REPAIR OF REACTOR VESSEL CLOSURE HEAD PENETRATION WELDS

#### 3.1.1 Component Identification

Turkey Point Units 3 and 4 Reactor Vessel Head Closure CRDM Nozzle Penetrations, Class 1

#### 3.1.2 Code Requirements for which Relief is Requested

The Construction Code of record for the Turkey Point Units 3 and 4 reactor vessel and head is the 1965 Edition of ASME Section III. ASME Section XI, subarticle IWA-4120 specifies the following: "Repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later Editions and Addenda of the Construction Code or of ASME Section III, either in their entirety or portions thereof, and Code Cases may be used." The licensee stated that the proposed repairs will be conducted in accordance with the 1989 Edition, of ASME Section III, Subsection NB and the alternatives requested.

The licensee stated this relief request is needed to support potential corrective actions resulting from the U.S. Nuclear Regulatory Commission (NRC) Bulletin 2001-01 inspections scheduled to be performed during the Turkey Point Unit 4 spring 2003 refueling outage. Specifically, subarticle IWA-4310 requires the repair of any flaw associated with the J-groove weld attaching the penetration to the head which cannot be accepted by the rules of the original Construction Code. Per subarticle IWA-4120, repair welding must be done in accordance with the original Construction Code. Therefore, for any J-groove weld excavation that resulted in a repair within 1/8 inch of the ferritic material of the vessel head, subarticle NB-4622 of Section III would require a postweld heat treatment (PWHT) for the repair weld or the use of a temper bead weld technique. Subparagraphs NB-4622.1 and NB-4622.5 require a postweld heat treatment for a repair weld.

3.1.3 Licensee's Proposed Alternative to Code

The licensee stated the PWHT parameters required by subarticle NB-4622 would be difficult to achieve on a reactor vessel head in containment and PWHT poses risk of distortion to the geometry of the head and vessel head penetrations. The temper bead procedure requirements, including preheat and postweld heat soaks contained in subarticle NB-4622, 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. Since the alternative is to utilize a temper bead weld procedure, the licensee stated that the majority of the PWHT control requirements as stated in the subparagraphs of subarticle NB-4622 no longer apply.

The licensee went on to state that subparagraph NB-4622.11 requires a 350° F preheat and a postweld soak at 450° F to 550° F for 4 hours. The proposed alternative does not require this heat treatment because the use of the extremely low hydrogen Gas Tungsten Arc Welding (GTAW) temper bead procedure does not require the hydrogen bake-out.

The subarticle NB-4622 temper bead procedure requires the use of the shielded metal arc welding (SMAW) welding process with covered electrodes. In the alternative, the licensee requests the use of the GTAW, which will be shielded with welding grade argon that typically produces porosity-free welds.

Subarticle NB-5245 requires progressive surface examination at the lesser of ½ the maximum weld thickness or ½ inch, as well as a surface examination of the final weld surface. The licensee proposes dye penetrant examination (PT) and ultrasonic examination (UT) no sooner than 48 hours after the weld has cooled to ambient temperature.

3.1.4 Licensee's Basis for Relief

The licensee stated that the Construction Code requires repairs to be postweld heat treated. The PWHT requirements would be extremely impractical to attain on an RPV head in containment without distortion of the head. In addition, the existing penetration to head weld procedures were not qualified with PWHT and cannot be so qualified at this time.

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 Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique," and will meet all other requirements of article IWA-4000. The alternative may be used to make repairs between P-No. 3 and P-No. 43 materials with an F-No. 43 filler metal. Specifically, the reactor vessel head is a P-No. 3 material and the affected welds are those J-groove welds attaching the P-No. 43 vessel head penetrations to the vessel head. The J-groove welds were made with F-No. 43 filler material.

The licensee stated that use of a GTAW temper bead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by Electric Power Research Institute (EPRI) and other organizations. EPRI Report GC-111050, "Ambient Temperature Preheat for Machine GTAW Temper Bead Applications," dated November 1998, demonstrates that carefully controlled heat input and bead placement allow subsequent welding passes to relieve stress and temper the heat-affected zones (HAZs) 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 postweld heat treats, as well as with no preheat and postheat. From that data, the licensee asserts that equivalent toughness is achieved in base metal and HAZs in both cases.

The licensee indicated that the temper bead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed. Many acceptable Procedure Qualifications Records (PQRs) and Welding Procedure Specifications (WPS) presently exist and have been used to perform numerous successful repairs. These repairs have included all of the Construction Book Sections of the ASME Code, as well as the National Board Inspection Code (NBIC). The use of the automatic or machine GTAW process utilized for temper bead welding allows more precise control of heat input, bead placement, and bead size and contour than the SMAW process required by NB-4622. Their position is that the very precise control over these factors afforded by the alternative provides more effective tempering and eliminates the need to grind or machine the first layer of the repair.

The licensee indicated that subarticle NB-4622 temper bead procedure requires a 350° F preheat and a postweld soak at 450° F to 550° F for 4 hours for P-No. 3 materials. Typically, these kinds of restrictions are used to mitigate the effects of the solution of atomic hydrogen in ferritic materials prone to hydrogen embrittlement cracking. The susceptibility of ferritic steels is directly related to their ability to transform to martensite with appropriate heat treatment. The P-No. 3 material of the reactor vessel head is able to produce martensite from the heating and cooling cycles associated with welding. However, the proposed alternative mitigates this propensity without the use of elevated preheat and postweld hydrogen bake-out.

The NB-4622.11 temper bead procedure requires the use of the SMAW welding process. 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 is from the evolution of gases created by the flux and from the slag that forms from the flux and covers the molten weld metal. Because of the possibility for contamination of the weld with hydrogen, NB-4622 temper bead procedures require preheat and postweld hydrogen bake-out. The licensee stated 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 adjusted to assure adequate shielding of the weld without creating a venturi effect that might draw oxygen or water vapor from the ambient atmosphere into the weld. The F-No. 43 (ERNiCrFe-7) filler metal that would be used for the repairs is not subject to hydrogen embrittlement cracking.

The licensee indicated that final examination of the repair welds would be a surface examination and would not be conducted until at least 48 hours after the weld had returned to ambient temperature following the completion of welding. Thus, in the unlikely event that hydrogen-induced cracking did occur, it would be detected by the 48-hour delay in examination.

Results of procedure qualification work undertaken to date indicate that the proposed alternative produces sound and tough welds. For instance, typical tensile test results have been ductile breaks in the weld metal. A typical set of Charpy test values showed absorbed energies, lateral expansions, and percent shear that were significantly greater for the HAZ than for the unaffected base metal. It can be shown from these results that the ambient temperature GTAW temper bead process has the capability of producing acceptable repair welds.

Based on the above information, FPL concluded that the proposed alternative ambient temperature temper bead weld technique provides a technique for repairing flaws in the reactor vessel closure head CRDM nozzle penetration welds that will produce sound and permanent repairs and that the procedure is an alternative to Code requirements that will provide an acceptable level of quality and safety.

3.1.5 Evaluation

The 1989 Edition of ASME Section III, paragraph NB-4622.11, "Temper Bead Weld Repair to Dissimilar Metal Welds or Buttering," states that whenever PWHT is impractical or impossible, limited weld repairs to dissimilar metal welds of P-No. 1 and P-No. 3 material or weld filler metal A-No. 8 (Section IX, QW-442) or F-No. 43 (Section IX, QW-432) may be made without PWHT or after the final PWHT, provided the requirements of the paragraphs NB-4622.11(a) through (g) are met.

The requirements of subarticles NB-4451, 4452, 4453, and 4622 of the 1989 Edition of ASME Section III are also applicable to the contemplated repairs. As an alternative to the PWHT time and temperature requirements of subarticle NB-4622, the proposed alternative will include the requirements of paragraphs 1.0 through 5.0 of Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique." Specifically, alternatives are being proposed for the following subparagraphs of ASME Section III, subarticle NB-4622:

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

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

Sub-subparagraph 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.

Sub-subparagraph 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.

Sub-subparagraph 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.

Sub-subparagraph NB-4622.6 establishes PWHT requirements for non-pressure-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.

Sub-subparagraph NB-4622.7 establishes exemptions from mandatory PWHT requirements. NB-4622.7(a) through NB-4622.7(f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Sub-subparagraph NB-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.

Sub-subparagraph NB-4622.8 establishes exemptions from PWHT for nozzle to component welds and branch connection to run piping welds. Sub-subparagraph NB-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 NB-4622.8(b) also does not apply because it discusses full penetration welds and the welds in question are specially designed pressure boundary, structural welds.

Sub-subparagraph 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.

Sub-subparagraph 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.

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

Sub-subparagraph NB-4622.11(a) requires surface examination prior to repair in accordance with Article NB-5000 (NB-4622.11(d)(3)). The proposed alternative will include surface examination prior to repair consistent with Article NB-5000.

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

Sub-subparagraph 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. In addition, subparagraph NB-4622.11(c) requires the Welding Procedure Specification include the following requirements:

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

Sub-subparagraph NB-4622.11(c)(2) requires the use of the SMAW process with covered electrodes meeting either the A-No. 8 or F-No. 43 classifications. The proposed alternative utilizes GTAW with bare electrodes meeting either the A-No. 8 or F-No. 43 classifications.

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

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

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

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

Sub-subparagraph NB-4622.11(c)(7) requires the preheated area to be heated from 450° F - 660° F for a minimum period of 4 hours. 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.

Sub-subparagraph 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 and requires the area to be welded be at least 50° F prior to welding. These limitations have been demonstrated to be adequate to produce sound welds.

Sub-subparagraph NB-4622.11(d)(1) requires PT after the hydrogen bake-out described in NB-4622.11(c)(7). The proposed alternative does not require the hydrogen bake-out nor does it require the in-process dye penetrant examination.

Sub-subparagraph NB-4622.11(d)(2) requires PT and radiography (RT) of the repair welds after a minimum of 48 hours at ambient temperature. UT is required, if practical. The proposed alternative includes the requirements for both UT and PT inspection after a minimum of 48 hours at ambient temperature. The geometry of the RPV head and the orientation of the inner bore of the CRDM nozzles make effective RT impractical. The thickness of the RPV head limits the sensitivity of the detection of defects in the new pressure boundary weld. The density changes between the base and weld metal and residual radiation from the base metal would render the film image inconclusive. The high area dose of radiation would cause fogging of the film. Because of these conditions, the NRC staff concludes RT is impractical for this type of repair.

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

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

Sub-subparagraph 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 that are pertinent to the SMAW manual welding process. The proposed alternative involves a machine GTAW process and requires that welding operators be qualified in accordance with ASME Section IX. The use of a machine process eliminates concern about obstructions, which might interfere with the welder's abilities since these obstructions will have to be eliminated to accommodate the welding machine.

The use of a GTAW temper bead welding technique to avoid the need for postweld heat treatment is based on research that has been performed by EPRI and other organizations. 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 the report shows the results of procedure qualifications performed with 300° F preheats and 500° F preheats, as well as with no preheat and postheat. From that data, it is clear that equivalent toughness is achieved in base metal and HAZs in both cases. The temper bead process has been shown effective by research, successful procedure qualifications, and many successful repairs performed since the technique was developed. Many acceptable PQRs and WPSs presently exist and have been utilized to perform numerous successful repairs. The use of the automatic or machine GTAW process utilized for temper bead welding allows more precise control of heat input, bead placement, and bead size and contour than the manual SMAW process required by subarticle NB-4622. The very precise control over these factors afforded by the alternative provides more effective tempering and eliminates the need to grind or machine the first layer of the repair.

The licensee was asked by the staff to discuss its plans for performing successive examinations on the repair weld that would be deposited approximately mid-wall of the RPV head. In their February 21, 2003, letter the licensee indicated that they would perform successive inspections on repaired RPV head penetration nozzles that establish a new pressure boundary. The repaired nozzles will receive ultrasonic inspection to include the new pressure boundary weld and at least 1 inch above the weld in the nozzle base material. The licensee also indicated that repaired nozzles will receive a bare metal visual examination of the RPV head surface. The staff concludes that this action provides an acceptable level of quality and safety and is, therefore, acceptable.

The NRC staff concludes that the licensee's proposed alternative for use of ambient temperature temper bead welding to repair flaws in the reactor vessel closure head CRDM nozzle penetrations as described in RR 30 provides an acceptable level of quality and safety. Therefore, relief is granted pursuant to 10 CFR 50.55a(a)(3)(i) for Turkey Point Units 3 and 4 third ISI interval.

## 3.2 INSERVICE INSPECTION PROGRAM RELIEF REQUEST NO. 31, CHARACTERIZATION OF REMAINING FLAWS

### 3.2.1 Component Identification

Turkey Point Units 3 and 4 Reactor Vessel Closure Head CRDM Nozzle Penetrations, Class 1

### 3.2.2 Code Requirements for which Relief is Requested

The ISI Code of record for Turkey Point Units 3 and 4 is the ASME Section XI, 1989 Edition, no Addendum. Subparagraph IWA-3100(a) requires that evaluation shall be made of flaws detected during an inservice examination as required by IWB-3000 for Class 1 pressure-retaining components.

Paragraphs IWA-3300(b) and IWB-3420 require that detected flaw(s) shall be characterized to establish the dimensions of the flaws.

Paragraphs IWB-2420(b) and (c) require reinspection of a flaw evaluated as acceptable for continued service for three successive periods.

### 3.2.3 Licensee's Proposed Alternative to Code

Pursuant to 10 CFR 50.55a(g)(5)(iii) & 50.55a(g)(6)(i) the licensee is seeking relief from characterizing flaws through NDE methods that remain in the CRDM J-groove weld after repair due to impracticality. Furthermore, the licensee is requesting relief from the successive inspection requirements of these flaws because it remains impractical to characterize the flaws through NDE.

### 3.2.4 Licensee's Basis for Relief

The licensee stated that the exterior surface of the RPV head will be examined for evidence of leakage. Penetrations with leakage will be investigated, and those with leakage will be repaired. The repair process consists of machining the lower portion of the CRDM nozzle to approximately mid-wall thickness of the RPV head above the existing J-groove weld, then welding the remaining nozzle to the wall of the reactor vessel. The licensee indicated not all of the flaws that were in the original pressure boundary J-groove weld will be removed through the machining process.

The licensee's position is that the original CRDM nozzle to RPV head weld configuration is extremely difficult to UT due to the compound curvature of the head and fillet radius. These conditions preclude ultrasonic coupling from the RPV and control of the sound beam in order to perform flaw sizing with reasonable confidence in measuring the flaw dimension from the inner surface of the head. The licensee indicated that testing is impractical because the technology to characterize potential flaw geometries in the J-groove weld does not exist. Another issue is the dissimilar metal interface between the Ni-Cr-Fe weld and the low alloy steel closure head, which increases the difficulty of UT. Similarly, impediments to examination from the outer surface of the RPV head exist due to proximity of adjacent nozzle penetrations according to the licensee. Based on these physical limitations, the licensee went on to state that the inability to characterize the flaws will continue in the foreseeable future, making subsequent examinations impractical.

For analysis purposes, the licensee assumed that a flaw(s) may exist in the J-groove weld from the weld surface to the RPV head base metal interface. They indicated that 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 metal. They stated that stress corrosion cracking (SCC) of carbon and low alloy steels is not a problem under boiling-water reactor or pressurized-water reactor conditions. Instead, an interdendritic crack, propagating from the J-groove weld area, is expected to blunt and cease propagation. They indicated that this has been the case for interdendritic SCC of stainless steel cladding cracks in charging pumps, and by recent events with PWSCC of Alloy 600 weld metals at Oconee 1 and V.C. Summer.

The licensee indicated a fracture mechanics evaluation would be performed to determine if the degraded J-groove weld metal 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 would be axially, or radially with respect to the nozzle. The licensee 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 RPV head, and that it would blunt and arrest at the butter-to-head interface. The licensee indicated that ductile crack growth through the Alloy 182 metal 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 RPV head metal are low, it will be assumed that a small flaw could initiate in the low ally steel metal and grow by fatigue. The licensee postulate that a small flaw in the RPV head 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 RPV head by fatigue crack growth under cyclic loading conditions associated with heatup and cooldown and other applicable transients.

The licensee stated that residual stresses will not be included in the flaw evaluation since it was demonstrated by analysis that these stresses are compressive in the low alloy steel base metal. The licensee indicated 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 would be performed for a postulated radial corner crack on the RPV head penetration, where stresses are the highest and the radial distance from the inside corner to the low alloy steel base metal is the greatest. Fatigue crack growth calculated for the remaining operation life should be small and the final flaw size will be shown to meet the requirements of the ASME Code for ferritic metals.

The licensee indicated that there would be a number of analyses performed on the new pressure boundary weld for the CRDM nozzle remnant. This is the weld to the remnant of the nozzle after machining the bottom portion of the nozzle from the original J-groove weld. One analysis used a three-dimensional model of a CRDM nozzle located at the most severe hillside orientation. The analytical model would include the RPV head, CRDM nozzle, proposed new weld, and remnant portions of the original J-groove welds. The model is analyzed for thermal transient conditions pertinent to Turkey Point Unit 3 and Unit 4 design specifications. The resulting maximum thermal gradients will be applied to the model along with the coincident internal pressure values. A computer program called ANSYS will then calculate the stresses throughout the model (which includes the new welds). The calculated stress values are then compared to the ASME Code, Section III, NB-3000 criteria for design conditions, normal operating and upset conditions, emergency conditions, faulted conditions, and testing conditions.

3.2.5 Evaluation

The repair plan consists of partially machining out the CRDM nozzle through the section of the J-groove weld that attaches the nozzle to the RPV head up to approximately mid-wall. At mid-wall, the remaining portion of the nozzle is welded and acts as the pressure-retaining boundary. This repair action changes the code category of the remnant J-Groove weld from Examination Category B-O, Pressure-Retaining Welds in Control Rod Housings, to a non-pressure-retaining weld, which is part of the base metal thickness. The newly deposited repair weld area is now treated as the new pressure-retaining weld and examined as Examination Category B-O under the ISI program.

The licensee’s position is that the original CRDM nozzle to RPV head weld configuration is extremely difficult to UT due to the compound curvature of the head and fillet radius. These conditions preclude ultrasonic coupling from the RPV and control of the sound beam in order to perform flaw sizing with reasonable confidence in measuring the flaw dimension from the inner surface of the head. The licensee indicated that the testing is impractical and that the technology does not exist to characterize flaw geometries that may exist in the J-groove weld. Another issue is the dissimilar metal interface between the Ni-Cr-Fe weld and the low alloy steel closure head, which increases the difficulty of UT. Impediments to examination from the outer surface of the RPV head exist due to proximity of adjacent nozzle penetrations according to the licensee. Based on these physical limitations, the licensee went on to state that the inability to characterize the flaws will continue in the foreseeable future, making subsequent examinations impractical.

The NRC staff agrees that examination of any flaws in the J-Groove weld region is impractical due to the configuration. The angle of incidence from the outer surface of the closure head base material does not permit perpendicular interrogation by ultrasonic shear wave techniques of circumferentially oriented flaws, and the physical proximity of the nozzle does not allow for longitudinal scrutiny of the area of interest. If examination of the J-groove weld were to be attempted from the inner diameter of the head, the cladding will provide an acoustic interface that will severely limit a confident examination of the weld material. Radiography of this area is impractical due to orientation of circumferentially oriented flaws being perpendicular to gamma and x-rays. Dye penetrant and magnetic particle examination will not provide useful volumetric information since these are surface techniques.

IWA-3300(a) of the ASME Code states that flaws detected by the preservice and inservice examinations shall be sized by the bounding rectangle or square for the purpose of description and dimensioning. IWA-3300(b) of the ASME Code states that flaws shall be characterized in accordance with IWA-3310 through IWA-3390 as applicable. IWB-3132.4(a) of the ASME Code states that components whose volumetric or surface examinations reveal flaws that exceed the acceptance standards listed in Table IWB-3410-1 shall be acceptable for service without the flaw removal, repair, or replacement if an analytical evaluation, as described in IWB-3600, meets the acceptance criteria of IWB-3600.

The licensee performed a flaw evaluation of Turkey Point Units 3 and 4 CRDM nozzle postulated J-groove weld flaws under Framatome documents 32-5014624, Rev. 2, dated May 31, 2002, and 32-5016966, Rev. 2, dated June 3, 2002. In the analyses, the licensee assessed the suitability of leaving degraded J-groove weld material in the respective RPV heads following the repair of a CRDM nozzle by the inside diameter temper bead weld procedure. The analyses assumed the following transients and frequencies (Unit 3 shown):

| Transient | Frequency |
|---|---|
| Heatup/Cooldown | 3.33 cycles/year |
| Plant Loading/Unloading | 50.00 cycles/year |
| Remaining Transients (Rapid Transient) | 46.67 cycles/year |

The licensee assumed a large flaw would have to be postulated if the J-groove weld was left in its original configuration after removal of the nozzle. The licensee's design specifies a chamfer at the inside corner of the remaining J-groove weld to limit the height of the weld along the beveled surface, from the inside corner to the low alloy steel head, to ½ inch. After machining, the initial flaw depth would be postulated to be 0.658 inches in the remaining J-groove weld at the outermost nozzle location. The outermost nozzle locations are considered the most highly stressed locations on the head when considering all locations. Based on an evaluation of fatigue crack growth into the low alloy steel head and considering the ASME Section XI requirements of the ASME Code for fracture toughness, the licensee concluded a postulated 0.658-inch radial crack in the Alloy 182 J-groove weld would be acceptable for 25 years of operation.

The NRC staff reviewed Framatome Calculation Summary Sheet 32-5014624-02, "TP-3 CRDM Nozzle IDTB J-Groove Weld Flaw Evaluation," submitted by a letter dated August 19, 2002. The NRC staff found that the methodology used by the licensee to determine flaw geometry, fracture toughness for crack arrest, fatigue crack growth in a primary water environment, and the overall fracture mechanics methodology was consistent with ASME Section XI requirements. The NRC staff concludes that the analysis assuming a 0.658-inch flaw remains in the "as left" J-groove weld provides reasonable assurance of the structural integrity of the RPV head and is, therefore, acceptable.

The licensee performed analyses of the CRDM nozzle temper bead weld repair design under documents 32-5014640, Rev. 2, dated May 20, 2002, for Unit 3 and document 33-5017337-00, dated March 12, 2002, for Unit 4. The licensee concluded the calculations demonstrated that the new CRDM nozzle-to-vessel weld, located at approximately mid-wall, meets the stress and fatigue requirements of the 1989 Edition of ASME Section III, for at least 14 years of operation. The NRC staff reviewed Framatome Calculation Summary Sheet 32-5014640-03, "Turkey Point 3 - CRDMH Temper Bead Bore Weld Analysis," submitted by letter dated August 19, 2002. The NRC staff found that the methodology used to calculate the cumulative fatigue usage factor was consistent with the requirements of ASME Section III, NB-3000. The resultant factor of 0.724 is less than the maximum allowable Code limit of 1.0. The NRC staff's review also found that the methodology used to calculate the design reinforcement, corrosion, and primary stress intensity criteria were consistent with ASME requirements. The NRC staff concludes these analyses provide reasonable assurance of structural integrity of the new CRDM nozzle-to-vessel weld and is, therefore, acceptable to the staff.

IWB-3132.4(b) of the ASME Code states where the acceptance criteria of IWB-3600 are satisfied, the area containing the flaw shall be subsequently reexamined in accordance with IWB-2420(b) and (c). IWB-2420(b) states if the flaw indications or relevant conditions are evaluated in accordance with IWB-3132.4 or IWB-3142.4, respectively, and the component qualifies as acceptable for continued service, the areas containing such flaw indications or relevant conditions shall be reexamined during the next three inspection periods listed in the schedules of the inspection programs of IWB-2410.

The remaining flaws (if any are present) are no longer in a pressure-retaining weld and, based on industry experience, they arrest at the junction of the clad/ferritic metal interface. The licensee has analyzed the flaw as acceptable for continued service based on the flaw growing to the clad/ferritic junction and blunting. The NRC staff concludes successive inspections of the “as-left” J-groove weld would not provide meaningful information as far as characterizing the flaws due to the impracticality of the examination as described before.

The NRC staff concludes that requiring the licensee to comply with the Construction Code repair and NDE requirements is impractical. The licensee's request and supporting information on the impracticality of characterizing flaws in remnant J-groove welds as stated under RR 31 for Turkey Point Units 3 and 4 provides assurance of structural integrity of the repair. Therefore, relief is granted pursuant to 10 CFR 50.55a(g)(6)(i) for Turkey Point Units 3 and 4 third ISI interval.

## 4.0 CONCLUSION

Based on the information provided in the licensee’s submittals, the NRC staff has determined that the proposed alternatives in RR 30, as described in Section 3.1.1 above, provides an acceptable level of quality and safety, and, therefore, it is authorized pursuant to 10 CFR 50.55a(a)(3)(i). Similarly for RR 31, the NRC staff has determined that it would be impractical to show that the flaws do not extend into the ferritic base metal and that for successive inspections it would be impractical to characterize the flaws by NDE. Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), RR 31 is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. These approvals are for the remainder of the third 10-year ISI intervals at Turkey Point Unit 3, which began February 22, 1994, and ends February 21, 2004, and for the remainder of the third 10-year ISI interval at Turkey Point Unit 4, which began April 15, 1994, and ends April 14, 2004. This authorization is limited to those components described in Sections 3.1.1 and 3.2.1 above.

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