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May 22, 2001

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

SUBJECT: Oconee Nuclear Station - Unit 2
Docket No. 50-270
Supplemental Information -
Request to use an Alternative to ASME Boiler and Pressure Vessel Code, Section XI in accordance with 10 CFR 50.55a(a)(3)(ii), (RR-01-06, Revision 2)

By letter dated May 7, 2001, Duke Energy Corporation (DEC) submitted a request, pursuant to 10 CFR 50.55a(a)(3)(ii), to use alternatives to the requirements of the ASME Boiler and Pressure Vessel Code, Section XI, Subsections IWA-4170(d), IWA-4500(e)(2), and IWA-4533, 1992 Edition with no addenda for Oconee Unit 2. In a telephone conference with the NRC on May 17, 2001, the NRC requested that DEC and Framatome ANP consider reducing the proprietary boundaries of Revision 1 submitted on May 15, 2001. This letter provides the requested information as Revision 2 to the May 15, 2001 letter. In addition, Revision 2 corrects the basis for the justification for the alternate to the post-welding holding period before non-destructive examination. These changes are indicated with change bars and bold text. Revision 2 replaces the Revision 1 Attachments A, F and G in their entirety.

Approval of this request would allow the use of alternatives to the examination requirements of Section III subsection NB-5245, as referenced by IWA-4170(d), Section XI subsections IWA-4500(e)(2) and IWA-4533 during and following repair of Class A Reactor Vessel (RV) head components. It has been evaluated and determined that compliance with the requirements of the referenced subsections would result in hardship and unusual difficulty without a compensating increase in the level of quality and safety. Entry into Mode 2 operation following completion of repairs is currently scheduled for May 27, 2001.

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A detailed description of this proposed alternative, including a background discussion and justification, is included as Attachment A to this letter.

Attachment A of this revision contains information proprietary to Framatome ANP (FRA-ANP). Brackets in Attachment A enclose proprietary information "[]". An affidavit from FRA-ANP is included as the replacement Attachment F. This affidavit establishes the basis on which the NRC, pursuant to 10 CFR 2.790 may withhold the information from public disclosure. The replacement Attachment G provides a non-proprietary version of this request.

Questions regarding this request may be directed to Robert Douglas at (864) 885-3073.

Very truly yours,

William R. McCollum,
Oconee Site Vice President

<u>Attachments</u>:

- This letter provides the revised attachments listed below:

  A - Request for Alternative, Serial Number 01-06, Revision 2 (Proprietary)
  F - Affidavit of R.W. Ganthner
  G - Request for Alternative, Serial Number 01-06, Revision 2 (Non-Proprietary)

- Attachments B, C, D, and E from Revision 1 of Request for Alternative, Serial Number 01-06, dated May 14, 2001, are unchanged by Revision 2 and should be inserted into Revision 2 at the appropriate locations.

cc w/att:

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cc (w/o att):

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**ATTACHMENT F**

DUKE ENERGY CORPORATION
RELIEF REQUEST 01-06,
Revision 2

**AFFIDAVIT OF**

**R. W. Ganthner**

AFFIDAVIT OF RAYMOND W. GANTHNER

A. My name is Raymond W. Ganthner. I am Vice-President of Engineering & Licensing for Framatome ANP, Inc. (FRA-ANP), and as such, I am authorized to execute this Affidavit.

B. I am familiar with the criteria applied by FRA-ANP to determine whether certain information of FRA-ANP is proprietary and I am familiar with the procedures established within FRA-ANP to ensure the proper application of these criteria.

C. In determining whether an FRA-ANP document is to be classified as proprietary information, an initial determination is made by the Unit Manager, who is responsible for originating the document, as to whether it falls within the criteria set forth in Paragraph D hereof. If the information falls within any one of these criteria, it is classified as proprietary by the originating Unit Manager. This initial determination is reviewed by the cognizant Section Manager. If the document is designated as proprietary, it is reviewed again by me to assure that the regulatory requirements of 10 CFR Section 2.790 are met.

D. The following information is provided to demonstrate that the provisions of 10 CFR Section 2.790 of the Commission's regulations have been considered:

(i) The information has been held in confidence by FRA-ANP. Copies of the document are clearly identified as proprietary. In addition, whenever FRA-ANP transmits the information to a customer, customer's agent, potential customer or regulatory agency, the transmittal requests the recipient to hold the information as proprietary. Also, in order to strictly limit any potential or actual customer's use of proprietary information, the substance of the following provision is included in all agreements entered into by FRA-ANP, and an equivalent version of the proprietary provision is included in all of FRA-ANP's proposals:

"Any proprietary information concerning Company's or its Supplier's products or manufacturing processes which is so designated by Company or its Suppliers and disclosed to Purchaser incident to the performance of such contract shall remain the property of Company or its Suppliers and is disclosed in confidence, and Purchaser shall not publish or otherwise disclose it to others without the written approval of Company, and no rights, implied or otherwise, are granted to produce or have produced any products or to practice or cause to be practiced any manufacturing processes covered thereby.

Notwithstanding the above, Purchaser may provide the NRC or any other regulatory agency with any such proprietary information as the NRC or such other agency may require; provided, however, that Purchaser shall first give Company written notice of such proposed disclosure and Company shall have the right to amend such proprietary information so as to make it non-proprietary. In the event that Company cannot amend such proprietary information, Purchaser shall prior to disclosing such information, use its best efforts to obtain a commitment from NRC or such other agency to have such information withheld from public inspection.

Company shall be given the right to participate in pursuit of such confidential treatment."

(ii) The following criteria are customarily applied by FRA-ANP in a rational decision process to determine whether the information should be classified as proprietary. Information may be classified as proprietary if one or more of the following criteria are met:

a. Information reveals cost or price information, commercial strategies, production capabilities, or budget levels of FRA-ANP, its customers or suppliers.

b. The information reveals data or material concerning FRA-ANP research or development plans or programs of present or potential competitive advantage to FRA-ANP.

c. The use of the information by a competitor would decrease his expenditures, in time or resources, in designing, producing or marketing a similar product.

d. The information consists of test data or other similar data concerning a process, method or component, the application of which results in a competitive advantage to FRA-ANP.

e. The information reveals special aspects of a process, method, component or the like, the exclusive use of which results in a competitive advantage to FRA-ANP.

f. The information contains ideas for which patent protection may be sought.

The document(s) listed on Exhibit "A", which is attached hereto and made a part hereof, has been evaluated in accordance with normal FRA-ANP procedures with respect to classification and has been found to contain information which falls within one or more of the criteria enumerated above. Exhibit "B", which is attached hereto and made a part hereof, specifically identifies the criteria applicable to the document(s) listed in Exhibit "A".

(iii) The document(s) listed in Exhibit "A", which has been made available to the United States Nuclear Regulatory Commission was made available in confidence with a request that the document(s) and the information contained therein be withheld from public disclosure.

(iv) The information is not available in the open literature and to the best of our knowledge is not known by General Electric, Westinghouse-CE, or other current or potential domestic or foreign competitors of FRA-ANP.

(v) Specific information with regard to whether public disclosure of the information is likely to cause harm to the competitive position of FRA-ANP, taking into account the value of the information to FRA-ANP; the amount of effort or money expended by FRA-ANP developing the information; and the ease or difficulty with which the information could be properly duplicated by others is given in Exhibit "B".

E. I have personally reviewed the document(s) listed on Exhibit "A" and have found that it is considered proprietary by FRA-ANP because it contains information which falls within one or more of the criteria enumerated in Paragraph D, and it is information which is customarily held in confidence and protected as proprietary information by FRA-ANP. This report

AFFIDAVIT OF RAYMOND W. GANTHNER (Cont'd.)

comprises information utilized by FRA-ANP in its business which affords FRA-ANP an opportunity to obtain a competitive advantage over those who may wish to know or use the information contained in the document(s).

RAYMOND W. GANTHNER

State of Virginia)
) SS. Lynchburg
City of Lynchburg)

Raymond W. Ganthner, being duly sworn, on his oath deposes and says that he is the person who subscribed his name to the foregoing statement, and that the matters and facts set forth in the statement are true.

RAYMOND W. GANTHNER

Subscribed and sworn before me
this 21st day of May 2001.

Brenda C. Maddox
Notary Public in and for the City
of Lynchburg, State of Virginia.
I was commissioned a Notary public as Brenda C. Cardona.

My Commission Expires July 31, 2003

## EXHIBITS A& B

### EXHIBIT A

Request for Alternate No. 01-06, Revision 2, Duke Energy Corporation, Oconee Nuclear Station, Unit 2.

### EXHIBIT B

The above listed document contains information, which is considered Proprietary in accordance with Criteria b, c, d, e and f of the attached affidavit.

DUKE ENERGY CORPORATION
Oconee Nuclear Station, Unit 2

Request for Alternates to the Requirements of the ASME Boiler and Pressure Vessel Code, Section XI

## Applicable Code Edition and Addenda

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 pre-service 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 ISI Code of record for Oconee Nuclear Station, Unit 2, third 10-year interval is the 1989 Edition of the ASME Code. The components (including supports) may meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein and subject to NRC approval. The codes of record for the repairs described within this request are the 1989 Section III and 1992 Section XI codes.

## Description of Code Requirements for Which an Alternative is Requested

There are three sections of the referenced codes for which alternatives are requested:

4. IWA-4170(d) requires that "… An item to be used for replacement meet all or portions of the requirements of later Editions and Addenda of the Construction Code or Section III …." The Unit 2 RV closure head original code of construction is the ASME Section III 1965 edition with Summer 1967 addenda. The 1989 ASME Section III code has been adopted for the repairs described herein. Section III, subsection NB-5245 requires that partial penetration joints be examined progressively using either magnetic particle (MT) or penetrant (PT) methods. The increments of the examination shall be the lesser of ½ the welded joint thickness or ½ inch. The surface of the finished weld shall also be examined by either method.

5. IWA-4500(e)(2) defines the band to be pre-heated and hence inspected following a temper-bead repair as the area of 1-1/2 times the component thickness or 5 inches, whichever is less.

6. Paragraph IWA-4533 specifies that "The weld repair as well as the preheated band shall be examined by the liquid penetrant method after the completed weld has been at ambient temperature for at least 48 hours. The repaired region shall be examined by the radiographic method and, if practical, by the ultrasonic method," following repair of dissimilar materials using the temper-bead process in accordance with IWA-4530.

Alternatives to the progressive MT or PT testing requirements of ASME Section III NB-5245, as referenced by Section XI IWA-4170(d), the post-repair inspection areas described in IWA-4500(e)(2), and the radiographic examination requirements and the examination hold period requirements of IWA-4533 are requested.

**Description of Proposed Alternatives**

In lieu of the requirements of IWA-4170(d), IWA-4500(e)(2), IWA-4533 the following alternatives are proposed:

6. IWA-4170(d): ASME Section III NB-5245 requires a progressive MT or PT to be performed during welding. It is proposed that the progressive testing be eliminated and that a volumetric examination of the weld using UT be performed after the weld is completed. In addition, a PT of the surface of the finished weld will be conducted.

7. IWA-4500(e)(2): Due to the unique geometry of the Control Rod Drive Mechanism (CRDM) inside Reactor Vessel (RV) head repairs, it is not practical to inspect the band area defined by IWA-4500(e)(2). [

] (See Figures 1 and 2). Post-repair inspections of the repaired areas will be done by a combination of remote and manual methods. In lieu of

inspecting the band area, it is proposed that the weld repair area be inspected by PT and UT. Examination of the [ ] with UT will be limited due to the geometry, which permits scanning in only one axial direction (See 4 below).

8. IWA-4533: Due to the thickness of the Unit 2 RV head and the complex geometry of the RV head in the area of the CRDM nozzles, examination of the repair regions by the radiographic method is not practical. It is proposed that examination by the ultrasonic method described in (2) be substituted for the radiographic method.

9. IWA-4533: The new pressure boundary weld contains a [ ] (See Figure 2). The [ ] of the weld cannot be inspected for transverse flaws with the UT probes and remote tooling to be used. In addition, the Heat Affected Zone (HAZ) of the RV head low alloy steel opposite the [ ] of the weld cannot be inspected by UT. In lieu of a complete UT inspection of the [ ] it is proposed that a combination of UT examinations described in (2) and surface PT examinations be performed.

10. IWA-4533: IWA-4533 stipulates that surface and volumetric inspections be performed after the completed weld has been at ambient temperature for at least 48 hours. It is proposed that the 48-hour hold be eliminated and that the volumetric and surface inspections be performed after the welds are completed and conditions have reached near ambient temperatures.

**Background Information**

Normal inspections of the Unit 2 RV head during a refueling outage discovered small amounts of boron emanating from the CRDM nozzle interface with the outside radius of the RV head. Boron deposits were discovered at this interface for CRDM nozzles Nos. 4, 6, 18, and 30. This pressure boundary degradation was reported to the NRC on April 28, 2001 in accordance with 10CFR50.72(b)(3)(ii).

Non-destructive examinations utilizing eddy current and ultrasonic methods are planned for the nozzle base metal of the nozzles described above. Liquid penetrant inspections are planned for each J-groove partial penetration weld connecting these CRDM nozzles to the inside radius of the RV head. Liquid penetrant inspections are also planned for portions of the outside diameter of the CRDM nozzles that project below the RV head. These inspections will help identify the probable leak path.

Experience gained from the repairs to the Unit 1 and Unit 3 CRDM nozzles indicated that more remote automated repair methods were needed to reduce radiation dose to repair personnel. So for the Unit 2 repairs, a remote semi-automated repair method is planned for each of the subject nozzles. Using a remote tool [ ] the RV head, each of the subject nozzles [

]

This new and innovative approach for repair of the subject CRDM nozzles will significantly reduce radiation dose to repair personnel. The total radiation dose for the remote semi-automated repair method currently is projected to be between 25 and 30 REM. In contrast, it is projected, using the Units 1 and 3 manual repair method for Unit 2 would result in a total radiation dose of 125 REM.

The automated repair method described above [

]

An analysis of the new pressure boundary welds, using a 3-dimensional model of a CRDM nozzle located at the most severe hillside orientation was performed. The software program ANSYS (general purpose finite element program that is used industry wide) was utilized 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 comparing the results to independently determined values.

The analytical model includes the RV Head, CRDM nozzle, repair weld and remnant portions of the original Alloy 600 welds (See Figure 3). The model is analyzed for thermal transient conditions as contained in the Reactor Coolant Functional Specifications. The resulting maximum thermal gradients are applied to the model along with the coincident internal pressure values. The ANSYS program then calculates the stresses throughout the model (including the repair welds). The stresses are post-processed by ANSYS routines to categorize stresses into categories that are 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 was assumed for the new pressure boundary weld.

The Primary Stress analysis for Design Conditions yields a maximum Primary General Membrane Stress Intensity (Pm) = 16.9 ksi as compared to the maximum allowed by the ASME Code = 27.0 ksi. This value is actually for the RV Head 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 is calculated as 1.0 for 25 years of future plant operation compared to the maximum allowed ASME Code criterion of 1.0. This value is for the point at the [

] the calculated fatigue usage factor for 40 years of future operation = 0.4 (compared to the maximum allowed ASME Code criterion of 1.0).

## Justification for Alternates

### 2. Justification for Alternate to Progressive Magnetic Particle or Penetrant Testing During Welding

For the repair process being used on the Oconee Unit 2 RV head, application of progressive surface inspection techniques, as required by IWA-4170(d), would require additional under-head entries. Twelve additional entries would be required to de-stage/re-stage the welding equipment and [ ] required for the penetrant test method. These additional entries would result in an estimated dose increase of 3 REM. (approximately 15% increase in total expected dose)

ASME Section III, paragraph NB-5245 requires a progressive surface examination of partial penetration welds to insure sound weld metal. The temper-bead process used for this repair would require a volumetric examination per the welding rules provided in ASME Section XI, IWA-4533. The intent of this examination is to confirm that the weld metal buildup, the fusion zone, and the parent metal opposite the weld are free of lack of fusion and laminar defects. The UT examination proposed can examine the new pressure boundary weld volume with the exception of the [ ] region as discussed in (4) below (See Figures 4 through 9 for extent of UT coverage). The finished weld surface will receive a liquid penetrant examination (See Figure 10 for extent of PT coverage). These inspections, along with steps taken to ensure quality during welding discussed later, provide assurance that unacceptable flaws in the new pressure boundary welds can be detected.

**(2) Justification for Using Alternate Examination Area**

The configuration of the new pressure boundary welds limits the ability to examine the band area defined by IWA-4500(e)(2). IWA-4500(e)(2), defines a band around the weld repair of at least 1-1/2 times the component thickness or 5 inches, whichever is less, that shall be preheated and maintained at a minimum temperature, based on the welding process to be utilized. For the repairs described herein, the GTAW process will be utilized. Due to the thickness of the RV head, the 5-inch minimum is utilized for definition of the band area.

The 5-inch band area is not directly applicable to the [ ] that are to be repaired. It is proposed that, in lieu of the inspections of the 5-inch band, the surfaces of the new pressure boundary weld receive both the PT and UT inspections. UT inspections of the RV head base material above the new weld through the nozzle would not be effective due to the interface between the nozzle and RV head low alloy steel. Thus, no UT inspections will be attempted above the new weld. PT inspections will be made of the inside nozzle surfaces in the Heat Affected Zone (HAZ) above the new weld (See Figure 10). A portion of the [ ] will receive a PT prior to installing the weld to identify any [ ] that might have occurred during original fabrication of the RV head. [ ] if discovered, will be dispositioned on a case-by-case basis, including, if needed, separate relief requests.

The new pressure boundary weld will only penetrate the inner surfaces of the RV head [ ] by approximately 1/8 inch. Remote enhanced video will be used during the welding operation to insure welding quality. The video equipment has the resolution capability to resolve a ½ mil diameter color contrast wire. The combination of the PT and UT examinations on the weld surfaces (See Figures 4-10 for extent of UT and PT coverage), the small depth of the weld penetration, and weld quality provisions will provide an acceptable level of quality and safety.

**(3) Justification for Using Alternate Volumetric Examination**

The geometry of the RV head and the orientation of the [ ] of the CRDM nozzles make effective radiographic examination impractical. The thickness of the RV head limits the sensitivity of the detection of defects in the new pressure boundary weld. It is proposed that examinations by the ultrasonic method be used in lieu of examinations by the radiographic method defined by IWA-4533.

UT examinations will be performed in accordance with the requirements of the 1989 ASME Code, Section III, subsection NB. The acceptance standards of Paragraph NB-5330 will be applied for the UT examinations.

The UT examination techniques are based upon industry practice for the examination of austenitic weld materials (Figure 4 identifies the areas to be inspected). The UT examinations consist of a combination of 2.25 Mhz 0 degree dual focused longitudinal wave (See Figure 5 for 0 degree beam coverage), 45 degree (See Figures 5-7 for 45L degree beam coverage) and 70 degree dual focused refracted longitudinal wave search units (See Figures 8 & 9 for 70L beam coverage). Table 1 provides the sizes and capabilities of the various transducers. The 0 degree longitudinal wave is performed to detect any lack of bond areas between the weld and original parent materials, inter-bead lack of fusion, and any laminar type cracking within the base material of the examination volume. The 45 and 70 degree search units are used to detect welding defects such as cracks or lack of fusion between weld beads.

A mock-up, representative of the final repair configuration, was used to demonstrate the UT capability to detect indications at the triple point and for underbead cracking (See Figure 11). A portion of the Midland RV closure head, complete with a CRDM nozzle was used for the mock-up. The materials of the Midland RV closure head and CRDM nozzles are very similar to those of Oconee Unit 2. This mock-up was machined and welded using the same processes that are being used for the described repairs.

The triple point is defined as the intersection of the RV head material, nozzle material, and the weld metal. The mock-up for the UT demonstration had notches machined in it. Each

notch was 1/8″ wide and 0.50″ long in the circumferential direction. Notches were milled in the triple point region at depths of 0.10″, 0.15″, and 0.25″ into the weld. A notch was also milled in the heat affected zone of the head base metal at 0.15″ below the weld to simulate under-bead cracking.

All of the calibration holes were detected with each transducer with very good signal to noise ratios. Additionally, the notches at the triple point could be detected and depth sized. The notch located in the heat affected zone used to simulate underbead cracking was also detected with a good signal to noise ratio. Based on these results the procedure is qualified.

These ultrasonic methods provide assurance that unacceptable flaws in the Reactor Vessel Head material in the vicinity of the new pressure boundary welds can be detected.

**(4) Justification for Alternate Examination of [ ] New Pressure Boundary Weld**

The [ ] of the weld cannot be inspected for axial (transverse flaws) with the manual and remote UT probes to be used for the examination as required by IWA-4533. 70% of the weld surface will be inspected by the UT method (See Figures 4-9 for UT beam coverage). PT will be used to examine the [ ] of the weld after final grinding (See Figure 10 for PT coverage). The UT probes cannot inspect the HAZ of the low alloy RV head opposite the [ ] of the weld. The UT probes will inspect 83% of the low alloy steel HAZ.

Remote enhanced video will be used during the welding operation to insure welding quality. The weld consumables to be used in the new pressure boundary weld consist of bare wire with no hygroscopic flux. The video equipment has the resolution capability to resolve a ½ mil diameter color contrast wire. The UT inspection that can be performed along with the PT inspection and the weld quality provisions described above will provide an acceptable level of quality and safety.

**(5) Justification for Alternate to Post-Weld Holding Period Before NDE**

IWA-4533 specifies that the weld region shall undergo volumetric examination after the weld repair area has been at ambient temperature for a minimum of 48 hours. The 48-hour hold is specified to assure that no delayed cold cracking in the ferritic steel HAZ has occurred. The weld consumables to be used in the new pressure boundary weld consist of bare wire with no hygroscopic flux. The welding will be performed at 300 degrees F, as required by IWA-4500(e)(2).

The 450-550 degrees F post-weld heat soak requirement of IWA-4532.2(d) is to assure that no delayed cold cracking in the ferritic steel HAZ occurs. The weld consumables to be used will consist of bare wire with no hygroscopic flux. The preheat temperature of 300 degrees F will be maintained during the post-weld soak for four hours. The combination of the low moisture absorbing weld process and maintaining the post-weld soak temperature at 300 degrees F for four hours will eliminate the possibility of hydrogen induced cracking.

Industry experience has found that delayed hydrogen cracking requires a hydrogen concentration above about 5ml/100g of deposited weld metal, and a weld and Heat Affected Zone (HAZ) with low ductility/toughness. Delayed hydrogen cracking tends to occur in carbon and alloy steel welds produced by processes which use a flux, e.g. shielded metal arc welding (SMAW), submerged arc welding (SAW), and flux cored arc welding (FCAW). The flux in these processes can pick up moisture that breaks down during welding to produce atomic hydrogen. The atomic hydrogen is partially absorbed by the weld metal and HAZ. Absorption of hydrogen, in sufficient quantity in low ductility material, may cause delayed hydrogen cracking. The GTAW process uses Argon gas as the shielding medium, a non hygroscopic flux.

Moisture contaminated shielding gas or high humidity environments may introduce hydrogen into GTAW welds. The Electric Power Research Institute (EPRI) performed tests where argon shielding gas was bubbled through a cylinder of water and then mixed with welding grade argon having a dew point of -70 degrees F to produce gas mixtures with dew points from -60 degrees F to +60 degrees F. At +60 degrees F dew point (an unrealistically high dew point), the measured hydrogen

concentration in test welds was 4.6 ml/100g of weld metal (Reference 3). This value falls in the extra low hydrogen range specified by American Welding Society (AWS). The EPRI study also measured the hydrogen content of bare filler material and found it to be less than 1 ml/100g of weld metal.

The EPRI work further showed that a 450 degrees F post-weld heat soak would reduce the already low hydrogen content to infinitesimally small values. Work by Coe and Moreton (Reference 4) determined that it takes only 0.3 hours at 450 degrees F to remove 95% of any hydrogen present. At 300 degrees F, the diffusivity rate measurements showed that only 0.7 hours is required to remove 95% of any hydrogen that is present. The proposed alternative will hold the post-weld heat soak at 300 degrees F for four hours.

In addition to the compelling data promulgated in the EPRI, and Coe and Moreton reports, Framatome-ANP has qualified the GTAW temper-bead process in support of ASME approval of Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper-Bead Technique for BWR CRD Housing/Stub Tube Repairs (Reference 5)." The supporting welding PQR's for this work, PQ7109 (Reference 6) and PQ7153 (Reference 7), are given in Attachment C and D, respectively. These qualifications were performed at room temperature with cooling water to limit the maximum interpass temperature to a maximum of 100 degrees F. These noted qualifications were performed on the same P-3 Group-3 base material as proposed for the Oconee Unit 2 repairs, using the same filler material, i.e. Alloy 52, with similar low heat input controls as will be used in the Oconee Unit 2 repairs. The qualifications did not include a post-weld heat soak.

As noted above, the repairs described herein will be made to the 1992 ASME Section XI Code. However, **Code Case N-432, Revision 1**[1], **deletes** the 48-hour hold period requirement. In summary, the proposed elimination of the 48-hour period prior to performing NDE is based on the: 1) use of bare wire with no hygroscopic flux with the 300 degree F preheat such that delayed hydrogen induced cracking is eliminated; And, 2) **the**

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**1 Approved by the ASME Main Committee (Action No. ISI-99-34) on February 16, 2001. The revision is scheduled to be published in June 2001.**

**recently approved code case that allows elimination of** the 48-hour hold period. These items, as well as the weld quality provisions described above, assure an acceptable level of quality and safety.

**The Quality and Safety Provided by the Proposed Alternative**

IWA-4170(d) mandates that the repair meet the examination provisions of the original design code of record or an adopted Section III code, subject to regulatory acceptance of the adopted Section III code. The progressive MT/PT requirements of ASME Section III NB-5245 addressed the inspection limitations caused by the partial penetration weld configuration. The combination of a post weld UT/PT examination described will ensure that unacceptable defects are identified.

There are two purposes to the examinations required by IWA 4500(e)(2) and IWA 4533:

1. The original rules were written within the context of repairing a detected flaw in base metal. As such, there was a concern for other existing flaws in the immediate area. The first purpose of the examination is to detect flaws that may be revealed as a result of the repair. In this case, there are no flaws in the base metal that are being repaired. The purpose of the repair is to [ ] The proposed inspection of the new weld surfaces within the heated band is sufficient to verify that defects have not been induced in the low alloy RV head material due to the welding process.

2. Performance of temper-bead repairs could result in under-bead hydrogen induced cracking. The second purpose of the examination is to verify that no under-bead cracking has occurred. The use of bare wire with no hygroscopic flux with the 300 degrees F preheat will reduce the potential for hydrogen induced cracking. However, the ultrasonic inspections planned are perfectly suited for the examination of the weld to head interface, through the weld thickness, to detect the possible presence of under-bead cracks.

The NDE inspection methods described herein will provide an acceptable level of quality and safety compared to the code requirements. The use of bare wire consumables with no hygroscopic flux and the 300 degrees F preheat will limit the potential for initiating cracks in the RV head base material. The above described UT methods can detect cracks that may form in 83% of the RV head base material opposite to the new weld. The UT and PT methods described will assure the weld quality meets ASME Section III subsection NB-5000 requirements. These inspections, along with the remote GTAW process, ensure that the welds will perform as designed and thus provide an acceptable level of quality and safety.

## Justification for Granting Relief

Compliance with the requirements of ASME Section III NB-5245 presents a hardship because of the significant added radiation exposure without any increase in quality or safety. The proposed alternative inspection utilizing UT and a PT of the finished weld in lieu of progressive PTs will ensure that any unacceptable indications in the repair weld are identified. The proposed alternative inspections provide an acceptable level of quality and safety.

DEC believes that compliance with the post-repair examination areas to the requirements of IWA-4500(e)(2) presents a hardship due to the [ ] The proposed examination areas will provide adequate evidence that the new pressure boundary welds and low alloy steel RV head meet the requirements of the ASME codes.

DEC believes that compliance with the post-repair examination methods required by IWA-4533 present a hardship or unusual difficulty without a compensating increase in the level of quality and safety. In order to use RT, the CRDM nozzle-to-RV head interface would have to be redesigned which would result in extensive through-wall repair that would subject the vessel to internal stresses and subject personnel to large radiation doses. Moreover, the results of a RT would be questionable because of density changes between the base and weld metal and residual radiation from the base metal would render the film image inconclusive. Therefore, compliance with the Code RT

requirement would create unusual difficulties and hardship. The proposed alternatives provide an acceptable level of quality and safety.

DEC believes that alternative for elimination of the 48-hour hold period meets the NRC's criteria for a hardship case per 10 CFR 50.55(a), (a)(3)(ii). Section IWA-**4533** requires a post-weld 48-hour hold period prior to performing the NDE required by Section XI. The need to repair the subject CRDM nozzles was identified during the current refueling outage. Therefore, these repairs were not part of the outage schedule or the ALARA dose estimate planning. Compliance with the requirement for a post-weld 48-hour hold period prior to performing the NDE required by IWA-4500(e)(2) would result in the addition of over 2-1/2 days to the refueling outage schedule. The additional time and delay of plant startup will constitute unusual hardships and burdens that are not necessary considering that the NDE that could be performed in a shorter time period following the repair and would provide an acceptable level of assurance of the quality and safety of the weld repairs. Any weld defects or cracking would be identified by the NDE performed before the 48-hour hold time. DEC's proposed approach will provide assurance of the structural integrity of the CRDM nozzles as demonstrated by a Section III analysis of the new weld configuration, in addition to the above described low hydrogen producing welding process, weld quality measures, and NDE procedures and processes.

As previously described: (1) the purpose of the 48-hour hold period is to assure that no undetected delayed hydrogen induced cold cracking in the ferritic steel HAZ has occurred; and (2) the welding processes used avoids delayed cold cracking. In recognition that the 48-hour hold period is an unnecessary burden and hardship for temper-bead weld repairs using the GTAW welding process with 300°F preheat, **Code Case N-432, Revision 1,** has deleted the 48-hour hold period requirement of IWA-**4533**.

The purposes of the 48-hour hold period are obviated by the shielded GTAW welding process with 300°F preheat. Accordingly, compliance with this requirement would not provide a compensating increase in the level of quality and safety. DEC concludes that the quality and safety of the repair is not increased by the 48-hour hold period and, therefore, that the

additional 2-1/2 day outage extension is an unnecessary hardship without a compensating increase in the level of quality and safety.

DEC believes the alternatives for inspection of the [ ] of the weld are justified. The UT of the full thickness portion of the weld, along with the partial UT and the PT of the [ ] provide assurance that cracks, should they form, could be detected. In addition, weld quality will be verified by video monitoring during the welding process.

Due to the previous repairs to the Oconee Unit 1 thermocouple nozzles and CRDM nozzle 21, the Unit 3 CRDM nozzles, the Unit 2 CRDM repairs described herein, and Primary Water Stress Corrosion Cracking concerns throughout the nuclear industry, Duke is planning to replace the Oconee Units 1, 2 and 3 RV heads. Orders for the new RV heads have been placed. The RV heads are to be replaced between 2003 and 2006.

In the interim, visual inspections of the RV closure head will continue during every planned and forced outage. The inspection schedule is based on the service life of the repairs described herein. A Framatome ANP evaluation has determined the time for a crack to grow 75% through-wall in the Alloy 600 nozzle material above the repair weld. The evaluation is documented in Engineering Information Record 51-5012772-00 entitled "ONS-2 CRDM Nozzle [ ] Temperbead Repair Lifetime Assessment" (Reference 8, See Attachment E). The evaluation considered CRDM nozzles both in the as-repaired condition and [ ] The evaluation is for initiation and crack growth due to primary water stress corrosion cracking (PWSCC). The evaluation concluded that a PT clear surface is expected to reach the criterion after 2.6 Effective Full Power Years (EFPY) for a repair [ ] If future inspections confirm that the bases for the service life predictions are not exceeded, then the service life prediction can be reset. If [ ] is used, the estimated corrosion time to breach the [ ] and the estimated crack growth time to 75% through-wall would yield [ ] estimated service life. The current schedule includes [ ] for the Oconee Unit 2 CRDM repairs.

Flaw growth rates for evaluation were assumed to follow the 4 mm/year rate described in Reference 8, which bounds any variation in flaw growth through the Alloy 600 material as a result of the weld repair.

Given these results, the proposed inspection schedules given above and the planned replacement dates for the Oconee Units 1, 2, and 3 RV closure heads are justified.

## Duration of the Proposed Alternative

The proposed alternatives are only applicable to the examinations to be made after repair to the subject Oconee Unit 2 RV head CRDM nozzles.

## Implementation Schedule

This Request for Alternate is associated with the ongoing repair of the Unit 2 RV head CRDM nozzles. Entry into Mode 2 operation is currently scheduled for May 27, 2001.

## References

1. Framatome Document 51-5012576-00, "Corrosion Evaluation of RV Head Penetration Repairs," dated April 18, 2001 (Attachment B)

2. EPRI NMAC Document TR-104748, "Boric Acid Corrosion Guidebook", April 1995

3. Electric Power Research Institute (EPRI), Document TR103354, "Temperbead Welding Repair of Low Alloy Pressure Vessel Steels; Guidelines," December 1993, Chapter 2, "Diffusion of Hydrogen in Low Alloy Steel," D. Gandy & S. Findland.

4. Journal of Iron and Steel Institute, April 1966, "Diffusion of Hydrogen in Low Alloy Steel," pages 366-370, F.R. Coe and B.A. Moreton

5. ASME Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper-Bead Technique for BWR CRD Housing/Stub Tube Repairs."

6. Framatome-ANP Welding Procedure Qualification Record PQ7109-00, dated February 23, 2001 (See Attachment C)

7. Framatome-ANP Welding Procedure Qualification Record PQ7153-00, dated May 8, 2001 (See Attachment D).

8. Framatome-ANP Document 51-5012772-00, "ONS-2 CRDM Nozzle [ ] Temperbead Repair Lifetime Assessment," dated May 4, 2001(Attachment E)

Originated By: Timothy D. Brown For 5/22/01
Melvin L. Arey Jr. Date

Reviewed By: [signature] 5-22-01
Calhoun W. Hendrix, Jr. Date

| **Table 1:**<br><br>**Oconee Unit 2 CRDM Replacement Weld**<br>**UT Search Unit Transducer Characteristics.** |
|---|

**Figure 1:**

**Oconee Unit 2 CRDM Machining**

[ ]

**Figure 2:**

**Oconee Unit 2 New CRDM Pressure Boundary Welds**

**Figure 3:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair**
**ANSYS Finite Element Mesh**

**Figure 4:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair Areas to be Examined**

[ ]

**Figure 5:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair, UT 0 degree and 45L Beam Coverage Looking Clockwise and Counter-clockwise**

**Figure 6:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair,
45L UT Beam Coverage Looking Down**

**Figure 7:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair, 45L UT Beam Coverage Looking Up**

**Figure 8:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair, 70L UT Beam Coverage Looking Down**

**Figure 9:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair,
70L UT Beam Coverage Looking Up**

**Figure 10:**

**Oconee Unit 2 CRDM Temper-Bead Weld Repair, PT Coverage**

**Figure 11:**

**Oconee Unit 2 CRDM Temperbead Weld Repair, UT Mock-Up Configuration**