April 11, 2005

Mr. R. T. Ridenoure
Division Manager - Nuclear Operations
Omaha Public Power District
Fort Calhoun Station, FC-2-4 Adm.
P.O. Box 550
Fort Calhoun, NE 68023-0550

SUBJECT: FORT CALHOUN STATION, UNIT NO. 1 – REQUEST FOR RELIEF FROM ASME CODE REPAIR REQUIREMENTS AND USING AN ALTERNATIVE FOR THE PRESSURIZER NOZZLE REPAIR (TAC NO. MC0196)

Dear Mr. Ridenoure:

By letter dated July 25, 2003, Omaha Public Power District (OPPD/the licensee) requested relief from American Society of Mechanical Engineers (ASME) Code repair requirements for its TE-108 pressurizer temperature nozzle weld repair for the Fort Calhoun Station, Unit 1 (FCS). In response to our request for additional information dated March 16, 2004, the licensee provided additional information on April 29, 2004. After discussions with the staff, OPPD provided a revised response dated September 30, 2004. By letter dated February 23, 2005, OPPD revised its request to reflect that the relief is only needed until the pressurizer is replaced in the fall of 2006. OPPD has cited Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(ii) as the basis for requesting relief. As an alternative to an ASME Code repair, OPPD has proposed to use a flaw evaluation to justify leaving the flaw in the J-groove weld. This flaw evaluation is based on the acceptance criteria of ASME Code, Section XI, IWB-3612, “Acceptance Criteria Based on Applied Stress Intensity Factor.”

The staff has determined that the FCS can be operated until the replacement of the pressurizer in the Fall of 2006 since the calculated applied stress intensity factor for the final flaw, considering six years’ crack growth, meets the IWB-3612 criteria for all loading conditions. The licensee has demonstrated that compliance with the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the licensee’s proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) for leaving the flaw in-place in the J-groove weld of the pressurizer.

The staff’s evaluation and conclusions are contained in the enclosed safety evaluation (SE). Pursuant to Section 2.390 of 10 CFR, we had determined that the enclosed SE did not contain proprietary information. However, we provided you with the opportunity to comment on the proprietary aspects. By email dated March 23, 2005, you provided comments regarding information in the SE that you had determined to be proprietary. The staff has reviewed these comments and has revised the SE.

If you have any questions, please contact Alan Wang at (301) 415-1445. This closes TAC No. MC0196.

Sincerely,

/RA by Jack Donohew for/
Robert A. Gramm, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosure: Safety Evaluation

cc w/encl: See next page

If you have any questions, please contact Alan Wang at (301) 415-1445. This closes TAC No. MC0196.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST FOR REPAIR OF PRESSURIZER TE-108 TEMPERATURE NOZZLE

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION

DOCKET NO.: 50-285

1.0 INTRODUCTION

In October 2000, the Omaha Public Power District (OPPD/the licensee) repaired a pressurizer instrument nozzle (TE-108) which had indicated leakage. The weld repair changed the pressure boundary from the pressurizer J-groove weld, which originally attached the TE-108 nozzle to the pressurizer lower shell inner surface, to a partial penetration Alloy 52/152 weld, which attaches the nozzle to an Alloy 152 pad welded to the lower shell outer surface using the temper bead method. However, the need for relief from American Society of Mechanical Engineers (ASME) Code, Section XI, IWB-3132.2, “Acceptance by Repair,” requirements in support of its 2000 repair concerning the flaw left in the J-groove weld had not been identified by the licensee until mid-2003.

By letter dated July 25, 2003, OPPD requested relief from certain requirements of the ASME Code for its TE-108 pressurizer temperature nozzle weld repair for Fort Calhoun Station, Unit No. 1 (FCS). This request included relief from IWB-3132.4(a) on non-destructive evaluation (NDE) of the detected flaws and IWB-3132.4(b) on successive examinations. The licensee requested, pursuant to 10 CFR 50.55a(a)(3)(ii), to use a flaw evaluation as an alternative to justify leaving the flaw in the J-groove weld. The flaw evaluation is based on the acceptance criteria of ASME Code, Section XI, IWB-3612, “Acceptance Criteria Based on Applied Stress Intensity Factor.” By letter dated February 23, 2005, OPPD revised its request to reflect that the relief is only needed until the pressurizer is replaced in the fall of 2006. The staff reviewed the licensee’s flaw evaluation and the information contained in the licensee’s September 30, 2004, response to the staff’s request for additional information, which included Westinghouse document CN-CI-02-74, Revision 2, “Evaluation of Fatigue Crack Growth of Postulated Flaw at Omaha Fort Calhoun Pressurizer Lower Shell Instrumentation Nozzle,” as an attachment. Revision 2 supersedes Revision 1 of CN-CI-02-74 submitted on April 29, 2004. The Westinghouse document is proprietary.

2.0 REGULATORY EVALUATION

The inservice inspection of ASME Code Class 1, Class 2, and Class 3 components shall be performed in accordance with Section XI of the ASME Code and applicable editions and addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the Nuclear Regulatory Commission (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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, 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) on the date twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. 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 Commission approval. The applicable ASME Code of record for the inservice inspection program at FCS at the time of inspection and repair is Section XI of the 1989 Edition of the ASME Code.

When flaws, associated with or without leakage, are detected by visual examinations, acceptance of them by supplemental examination, repairs, replacement, or analytical evaluation shall be in accordance with IWB-3140, "Inservice Visual Examinations." However, because the evaluation analysis and acceptance criteria for an evaluation of a flaw detected by visual examinations are not defined in IWB-3142.4, "Acceptance by Analytical Evaluation," the licensee chose to apply the more stringent requirements of IWB-3132.2 for flaw removal and IWB-3132.4 for flaw NDE and IWB-3130, "Inservice Volumetric and Surface Examinations," for successive examinations to this application and sought relief from these requirements.

3.0 <u>TECHNICAL EVALUATION</u>

3.1 Specific Code Requirements for which Relief is Requested

IWB-3132.2 of Section XI of the 1989 Edition of the ASME Code requires that, "the flaw shall be either removed by mechanical methods or the component repaired to the extent necessary to meet the acceptance standards of IWB-3000." This requirement applies to the licensee's disposition of the flaw in the remaining J-groove weld of the TE-108 nozzle.

Paragraph (a) of IWB-3132.4 requires, "[c]omponents whose volumetric or surface examination reveals flaws that exceed the acceptance standards listed in Table IWB-3410-1 shall be acceptable for service...if an analytical evaluation, as described in IWB-3600, meet the acceptance criteria of IWB-3600." Paragraph (b) of IWB-3132.4 requires, "the area containing the flaw shall be subsequently reexamined in accordance with IWB-2420(b) and (c)." Part of paragraph (a) of IWB-3132.4 applies to NDE of the detected flaw, and paragraph (b) of IWB-3132.4 applies to the successive examinations of the detected flaw.

3.2 Proposed Alternative to Code

In lieu of the requirements described in Section 3.1 of this safety evaluation (SE), the licensee proposed to use IWB-3132.4(a) in demonstrating that the evaluation for the flaw in the J-groove weld meets the IWB-3612 flaw acceptance criteria, so that the flaw removal requirement of IWB-3132.2 and flaw NDE and reexamination requirements of IWB-3132.4 need not to be performed.

3.3 Licensee's Basis for Relief

The licensee stated that compliance with the specified requirements of this section, i.e., removing the through-wall flaw in the J-groove weld for the TE-108 nozzle, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. These difficulties include access to the interior of the pressurizer, machining or grinding out the J-groove weld, and a much higher radiation exposure to the personnel during the repair activity. Consequently, the licensee, pursuant to 10 CFR 50.55a(a)(3)(ii), applied the alternative described in Section 3.2 of this SE to justify continued operation of FCS until the replacement of the pressurizer in the Fall of 2006, without removing the flaw in the J-groove weld of the TE-108 nozzle and without performing any Code-required successive examinations related to this flaw.

3.4 Staff Evaluation

The hardship identified by the licensee includes access to the interior of the pressurizer, machining or grinding out the J-groove weld, and a much higher radiation exposure to personnel during the repair activity. Within this context, the licensee proposed to demonstrate the hardship that would result from implementing the flaw removal requirement of IWB-3132.2 and flaw NDE and reexamination requirements of IWB-3132.4(b). The staff agrees that access to the interior of the pressurizer and the concern of much higher radiation exposure to personnel during the repair activity make machining or grinding out the J-groove weld in accordance with the Code very difficult and would involve a hardship. Consequently, this SE focuses on the evaluation of the flaw in the J-groove weld to demonstrate that compliance with the specified requirements of the Code do not have a compensating increase in the level of quality and safety.

The temper-bead weld repair for the TE-108 pressurizer nozzle relocates the pressure boundary from the pressurizer shell inner surface to the shell outer surface and leaves the flaw in the original J-groove weld. To demonstrate structural integrity of the original J-groove weld for six years' operation after this repair, the licensee performed a Section XI flaw evaluation permitted by IWB-3132.4(a). It should be noted that applying IWB-3132.4(a) alone in disposition of a detected flaw requires no relief. However, using IWB-3132.4(a) to evaluate a detected flaw in support of acceptance by repair specified in IWB-3132.2 is considered by the staff as an alternative to the Code, and a relief is required.

A typical flaw evaluation requires the determination of the initial flaw size, the applied stress intensity factor (applied K), fatigue crack growth, and stability of the final crack. These elements are addressed in Westinghouse Report CN-CI-02-74, Revision 2 and are evaluated by the NRC staff in the following paragraphs.

3.4.1 Initial Flaw Size

The initial flaw is assumed to be a double-sided crack that has propagated through the J-groove weld to the low alloy steel material that comprises the pressure boundary (i.e., the pressurizer shell). The staff examined the licensee's initial crack size calculation and confirmed that the initial flaw size represents the radial cross section of the J-groove weld, which is the worst possible radial crack that could exist in the weld. This approach of characterizing a flaw of unknown size is conservative and has become a standard industry practice, and therefore is acceptable to the staff.

3.4.2 Applied Stress Intensity Factor

For a flaw susceptible to fatigue crack growth or any type of stress corrosion cracking (SCC), the appropriate crack growth equation is needed to predict the final crack size for given operating time for the unit with the flawed component. In this application, fatigue crack growth is the only credible degradation mechanism because during normal operation hydrogen overpressure in the Reactor Coolant System significantly reduces the oxygen level such that SCC into the low alloy steel is not likely to happen. This is supported by current industry experience and laboratory observations, and is consistent with past NRC evaluations of reactor pressure vessel control rod drive mechanism nozzle repairs. The fatigue crack growth equation is a function of the applied K. The licensee used the Raju-Newman applied K formulation documented in NASA Technical Memorandum 85793, "Stress-Intensity Factor Equations for Cracks in Three-Dimensional Finite Bodies Subjected to Tension and Bending Loads." The staff evaluated the applicability of the Raju-Newman applied K solution to the current application, considering the differences of the relative hole size and crack geometry between the current application and Raju-Newman's models. The results from this study indicate that the subject nozzle configuration satisfies three of the four applicability criteria associated with the Raju-Newman solution: (1) the crack depth to length ratio of 0.2 to 2.0, (2) the crack depth to plate thickness ratio of less than 0.8, and (3) the extended hole size (hole radius + crack length) to the component length ratio of less than 0.5. The fourth criterion, the ratio of the hole radius to the component thickness, does not satisfy the lower limit of 0.5. Physically, this means that the subject geometry has more material ahead of the crack front than that of the Raju-Newman model. The staff has concluded that using the Raju-Newman solution in this application is conservative, and therefore is acceptable to the staff.

3.4.3 Fatigue Crack Growth

Fatigue crack growth of the postulated flaw documented in Westinghouse Report CN-CI-02-74, Revision 2 is based on 10 cycles of heatup and 10 cycles of cooldown transients. The transient cycles were derived from a review of the design specifications dated February 21, 1994, by combining similar transients and eliminating relatively insignificant transients to simplify the fatigue crack growth calculation. The staff accepts the current transient and cycle selection based on the following: (1) inclusion of the in-surges makes the heatup and cooldown transients much more severe than those without the in-surges (stresses associated with in-surges are three times of those associated with normal heatup and cooldown transients) and the secondary transients such as the turbine trip transient are a minor contributor according to Report CN-CI-02-74, Rev. 0, and (2) the 10 heatup and 10 cooldown cycles are conservative for an operation of six years.

To assess the bounding nature of the assumed heatup and cooldown rates and the associated insurges, the staff requested the licensee to provide plant-specific information based on operating data. The licensee provided operating data of pressurizer steam space temperature for the last three cooldown and heatup cycles in its response dated September 30, 2004. Since the pressurizer is operated close to the saturation pressure, the approximately same pressure for the steam space and the coolant space implies that the temperature of the steam space and the coolant space is also approximately the same. Therefore, operating data of the steam space temperature is a good indication of the coolant space temperature. The staff has examined this data and determined that the FCS pressurizer cooldown and heatup rates and the magnitude of insurges are bounded by those assumed in the analysis.

The fatigue crack growth rate used in the calculations is from Appendix A of Section XI of the ASME Code. This curve applies to carbon and low alloy ferritic steels exposed to a water environment. Using the appropriate ASME Code fatigue crack growth rate in the flaw evaluation is consistent with industry practice and is acceptable to the staff.

3.4.4 Final Crack Stability Evaluation

The licensee's final step of flaw evaluation involves applied K calculations for final flaw sizes under various loading conditions using linear elastic fracture mechanics, and examination for crack stability using the IWB-3612 criteria. The final flaw sizes include fatigue crack growth for 10 heatup and 10 cooldown cycles. The loading conditions include (1) cooldown (Level A), (2) turbine and reactor trip (Level B), (3) loss of secondary flow (Level C), and (4) the insurges (Level A). The results from the calculation and examination are tabulated in Westinghouse Report CN-CI-02-74, Revision 2, which show that all cases meet the IWB-3612 flaw acceptance criteria. Although cooldown and insurges belong to the same Level A loading category, the time corresponding to the worst stresses for these transients differs considerably. Therefore, these transients can be evaluated individually and no load combinations are necessary. Based on the above discussion, the staff determines that the crack stability evaluation is acceptable.

3.4.5 Future Inspections

Separately, the licensee responded in the letter of September 30, 2004, to the staff concern about the effect of primary water SCC (PWSCC) on the new Alloy 52/152 weld, which is part of the pressure boundary now. The licensee stated that it will perform bare metal visual examination of all pressurizer penetrations and the external portion of the TE-108 nozzle penetration and the associated repair weld every refueling outage until the Fall of 2006 when the pressurizer is scheduled to be replaced. Further, in its response to Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized Water Reactors," the licensee stated that it plans to apply the same criteria proposed by the Westinghouse Owners Group for pressurizer heater sleeves in a letter dated January 30, 2004, to every pressurizer penetration during the Spring 2005 outage. Consequently, the licensee will notify the NRC and perform additional NDE if it has found any pressurizer penetration circumferential cracking during the Spring 2005 outage.

The licensee's proposed inspection for the TE-108 temperature nozzle is appropriate because: (1) for the new Alloy 52/152 weld, the industry operating and test data revealed that the PWSCC incubation time for Alloy 690/Weld 52 and 152 material is much longer than six years, and (2) for the remaining J-groove weld, the final crack considering fatigue crack growth for six years remains stable. The second reason also justifies the relief from IWB-3132.2 on removing detected flaws and IWB-3132.4 on flaw NDE and successive examinations, which would result in unusual difficulty without a compensating increase in the level of quality and safety.

4.0 CONCLUSIONS

Based on the above evaluations, the staff concludes that FCS can be operated with the detected flaw left in the original J-groove weld of the pressurizer TE-108 temperature nozzle until the Fall of 2006 when the pressurizer is scheduled to be replaced. The staff has determined that compliance with the requirements of ASME Code, Section XI, IWB-3132.2 on removing flaws in the original J-groove weld of the pressurizer temperature nozzle and IWB-3132.4 on flaw NDE and successive examinations would result in unusual difficulty without a compensating increase in the level of quality and safety. Good cause has been shown for the relief from the Code, therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the staff authorizes this alternative until the replacement of the pressurizer in Fall of 2006. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: S. Sheng

Date: February 28, 2005