UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ALTERNATIVE FROM AUGMENTED INSPECTION OF

REACTOR PRESSURE VESSEL CIRCUMFERENTIAL WELDS

PERRY NUCLEAR POWER PLANT, UNIT NO. 1

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, ET AL.

DOCKET NO. 50-440

1.0 INTRODUCTION

By letter dated August 28 1997, as supplemented by letters dated September 4 and September 16, 1997, Centerior Energy (the licensee) requested an alternative to performing the reactor pressure vessel (RPV) circumferential shell weld examination requirements of both the American Society of Mechanical Engineers (ASME), *Boiler and Pressure Vessel Code* (B&PVC), Section XI, 1983 edition through summer 1983 addenda (inservice inspection), and the augmented examination requirements of 10 CFR 50.55a(g)(6)(ii)(A)(2) for the Perry Nuclear Power Plant (PNPP), Unit No. 1. The alternative was proposed pursuant to the provisions of 10 CFR 50.55a(g)(6)(ii)(A)(5) and 10 CFR 50.55a(a)(3)(i), and is consistent with information contained in Information Notice (IN) 97-63, "Status of NRC Staff Review of BWRVIP-05." The September 4, 1997, letter contained supplemental information related to plant procedures and operator training. The September 16, 1997, letter provided clarification regarding the regulatory basis for the request and the proposed alternative.

The alternative proposed by Centerior Energy is the performance of inspections of essentially 100 percent of the PNPP RPV shell longitudinal seam welds and essentially 0 percent of the RPV shell circumferential seam welds during Refueling Outage 6, which will result in partial examination of the circumferential welds at or near the intersections of the longitudinal and circumferential welds.

The requirement for inservice inspections, which include RPV circumferential weld inspection, derives from the Technical Specifications (TS) for PNPP which state that the inservice inspection (ISI) and testing of the ASME Code Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME B&PVC and applicable addenda as required by 10 CFR 50.55a(g). Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components shall 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 the ASME Code, Section XI, incorporated by reference in 10 CFR 50.55a(b) on the date 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable ASME Code, Section XI, for PNPP, during the first 10-year ISI interval is the 1983 edition through the summer 1983 addenda.

Section 50.55a(g)(6)(ii)(A) to Title 10 of the *Code of Federal Regulations* requires that licensees perform an expanded RPV shell weld examination as specified in the 1989 edition of Section XI, on an "expedited" basis. "Expedited" in this context, effectively meant during the inspection interval when the rule was approved or the first period of the next inspection interval. The final rule was published in the Federal Register on August 6, 1992 (57 FR 34666). By incorporating into the regulations the 1989 edition of the ASME Code, the NRC staff required that licensees perform volumetric examination of "essentially 100 percent" of the RPV pressure-retaining shell welds during all inspection intervals. Section 50.55a(a)(3)(i) to Title 10 of the *Code of Federal Regulations* indicates that alternatives to the requirements in 10 CFR 50.55a(g) are justified when the proposed alternative provides an acceptable level of quality and safety.

By letter dated September 28, 1995, as supplemented by letters dated June 24 and October 29, 1996, and May 16, June 4, and June 13, 1997, the Boiling Water Reactor Vessel and Internals Project (BWRVIP), a technical committee of the BWR Owners Group, submitted the proprietary report, "BWR Vessel and Internals Project, BWR Reactor Vessel Shell Weld Inspection Recommendations (BWRVIP-05)," which proposed to reduce the scope of inspection of the BWR RPV welds from essentially 100 percent of all RPV shell welds to 50 percent of the axial welds and 0 percent of the circumferential welds. By letter dated October 29, 1996, the BWRVIP modified their proposal to increase the examination of the axial welds to 100 percent from 50 percent, while still proposing to inspect essentially 0 percent of the circumferential RPV shell welds, except that the intersection of the axial and circumferential welds would have included approximately 2-3 percent of the circumferential welds.

On May 12, 1997, the NRC staff and members of the BWRVIP met with the Commission to discuss the NRC staff's review of the BWRVIP-05 report. In accordance with guidance provided by the Commission in Staff Requirements Memorandum (SRM) M970512B, dated May 30, 1997, the staff has initiated a broader, risk-informed review of the BWRVIP-05 proposal.

In IN 97-63, the staff indicated that it would consider technically justified alternatives to the augmented examination in accordance with 10 CFR 50.55a(a)(3)(i) and (ii), and 10 CFR 50.55a(g)(6)(ii)(A)(5), from BWR licensees who are scheduled to perform inspections of the BWR RPV circumferential welds during the fall 1997 or spring 1998 outage seasons. Acceptably justified alternatives would be considered for inspection delays of up to 40 months or two operating cycles (which ever is longer) for BWR RPV circumferential shell welds only.

2.0 BACKGROUND - Staff Assessment of BWRVIP-05 Report

The staff's independent assessment of the BWRVIP-05 proposal is documented in a letter dated August 14, 1997, to Carl Terry, BWRVIP Chairman. The staff concluded that the industry's assessment does not sufficiently address risk, and additional work is necessary to provide a complete risk-informed evaluation.

The staff's assessment was performed for BWR RPVs fabricated by Chicago Bridge and Iron (CB&I), Combustion Engineering (CE), and Babcock & Wilcox (B&W). The staff assessment identified cold over-pressure events as the limiting transients that could lead to failure of BWR RPVs. Using the pressure and temperature resulting from a cold over-pressure event in a foreign reactor and the parameters identified in Table 7-1 of the staff's independent assessment, the staff determined the conditional probability of failure for axial and circumferential welds fabricated by CB&I, CE, and B&W. Table 7-9 of the staff's assessment identifies the conditional probability of failure for the reference cases and the 95 percent confidence uncertainty bound cases for axial and circumferential welds fabricated by CB&I, CE and B&W. B&W fabricated vessels were determined to have the highest conditional probability of failure. The input material parameters used in the analysis of the reference case for B&W fabricated vessels resulted in a reference temperature (RT_{NDT}) at the vessel inner surface of 114.5°F. In the uncertainty analysis, the neutron fluence evaluation had the greatest RT_{NDT} value (145°F) at the inner surface. Vessels with RT_{NDT} values less than those resulting from the staff's assessment will have less embrittlement than the vessels simulated in the staff's assessment and should have a conditional probability of vessel failure less than or equal to the values in the staff's assessment.

The failure probability for a weld is the product of the critical event frequency and the conditional probability of the weld failure for that event. Using the event frequency for a cold over-pressure event and the conditional probability of vessel failure for B&W fabricated circumferential welds, the best-estimate failure frequency from the staff's assessment is 6.0×10^{-10} per reactor year, and the uncertainty bound failure frequency is 3.9×10^{-8} per reactor year.

3.0 LICENSE TECHNICAL JUSTIFICATION

The licensee indicated in the August 28, 1997, letter that the basis for requesting the alternative inspections is the BWRVIP-05 report, which stated that the probability of failure of BWR RPV circumferential shell welds is orders of magnitude lower than that of the axial shell welds. This conclusion was also demonstrated in the staff's independent assessment of the BWRVIP-05 report. The BWRVIP-05 report indicates that, for a typical BWR RPV, the failure probability for axial welds is 2.7×10^{-7} and the failure probability for circumferential welds is 2.2×10^{-41} for 40 years of plant operation.

The licensee calculated the RT_{NDT} value for limiting PNPP circumferential welds at the end of the requested relief period using the methodology in Regulatory Guide (RG) 1.99, Revision 2. Since there are no circumferential welds in the beltline region, the limiting circumferential welds are 1B13-AB, which is 6 inches below the bottom of active fuel, and 1B13-AC, which is 16 inches above the top of active fuel. Relative to RT_{NDT}, the licensee determined that weld 1B13-AB is the limiting circumferential weld in the vessel. The RT_{NDT} values calculated in accordance with RG 1.99, Revision 2, depend upon the neutron fluence, the amounts of copper and nickel in the circumferential weld, and its unirradiated RT_{NDT}. The licensee determined the maximum neutron fluence at the end of the next two operating cycles at the inner surface of circumferential weld 1B13-AB to be 0.058×10^{19} n/cm^2 and for circumferential weld 1B13-AC to be 0.090×10^{19} n/cm^2. The amounts of copper and nickel in circumferential weld 1B13-AB is 0.03 percent and 0.81 percent, respectively. The amounts of copper and nickel in circumferential weld 1B13-AC is 0.04 percent and 0.97 percent, respectively. The plant-specific unirradiated RT_{NDT} for circumferential weld 1B13-AB is -20°F and for weld 1B13-AC is -60°F. Using these parameters and the methodology in Regulatory Guide 1.99, Revision 2, the licensee determined that the RT_{NDT} value for circumferential weld 1B13-AB at the end of the relief period is 6°F and for circumferential weld 1B13-AC is -17.1°F, which are less than the reference case for the B&W fabricated vessels in the staff's assessment. Since the RT_{NDT} of PNPP circumferential welds are less than the values in the staff's assessment, the licensee concluded that the conclusions of the BWRVIP-05 report are bounded for the PNPP RPV.

The licensee assessed the systems that could lead to a cold over-pressurization of the PNPP RPV. These included the high pressure coolant injection, reactor core isolation cooling, standby liquid control, control rod drive and reactor water cleanup systems. In all cases, the operators are trained in methods of controlling water level within specified limits in addition to responding to abnormal water level conditions during shutdown. Plant-specific procedures have been established to provide guidance to the operators regarding compliance with the TS pressure-temperature limits. On the basis of the pressure limits of the operating systems, operator training, and established plant-specific procedures, the licensee determined that a nondesign basis cold over-pressure transient is unlikely to occur during the next two operating cycles. Therefore, the licensee concluded that the probability of a cold over-pressure transient is considered to be less than or equal to that used in the staff's assessment.

4.0 STAFF REVIEW OF LICENSEE TECHNICAL JUSTIFICATION

The staff confirmed that the RT_{NDT} value for the circumferential welds at the end of the relief period are less than the values in the reference case and uncertainty analysis for the B&W fabricated vessels. RT_{NDT} is a measure of the amount of irradiation embrittlement. Since the RT_{NDT} values are less than the value in the reference case and the values in the uncertainty analysis for B&W fabricated vessels, the PNPP RPV will have less embrittlement than the B&W fabricated vessels and will have a conditional probability of vessel failure less than or equal to that estimated in the staff's assessment.

Based on pressure limits on the operating systems, and the licensee's operator training and established procedures, the probability of a cold over-pressure transient should be minimized during the next two operating periods.

5.0 CONCLUSIONS

1) Based on the licensee's assessment of the materials in the circumferential welds in the PNPP RPV, the conditional probability of vessel failure should be less than or equal to that estimated from the staff's assessment.

2) Based on the licensee's operator training and established procedures, the probability of cold over-pressure transients should be minimized during the next two operating periods.

3) Based on the previous two conclusions, the staff concludes that the PNPP RPV can be operated during the next two operating periods with an acceptable level of quality and safety and the inspection of the circumferential welds can be delayed for two operating periods.

Therefore, the proposed alternative to performing the RPV examination requirements of the ASME B&PVC, Section XI, 1983 edition through summer 1983 addenda, and the augmented examination requirements of 10 CFR 50.55a(g)(6)(ii)(A)(2) at PNPP for circumferential shell welds for two operating cycles is authorized pursuant to 10 CFR 50.55a(a)(3)(i).

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