ENCLOSURE 1

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

BAW-2148P, REVISION 1

COMMONWEALTH EDISON COMPANY

ZION, UNITS 1 AND 2

DOCKET NOS. 50-295 AND 50-304

1.0 INTRODUCTION

By letter dated May 11, 1992, Commonwealth Edison Company (CECo or the licensee) submitted a Babcock and Wilcox Owners Group (B&WOG) Materials Committee report, BAW-2148P, Rev. 1, entitled "Low Upper-Shelf Toughness Fracture Analysis of Reactor Vessels of Zion Units 1 and 2 for Load Level A & B Conditions," [1] for staff review and approval. CECo also submitted the B&WOG's response to the staff's request for additional information [2] in a letter dated July 29, 1993. This effort was intended to demonstrate through fracture mechanics analysis that there exist margins of safety against fracture equivalent to those required by Appendix G of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section III, for beltline welds having upper-shelf energy (USE) values below the 50 ft-lb screening criterion.

2.0 EVALUATION

The licensee followed the procedures and criteria developed by the ASME Section XI Working Group on Flaw Evaluation, which was released as ASME Code Case N-512 [3] on February 12, 1993. According to the ASME Section XI criteria for Level A and B conditions (which are the same as those in Code Case N-512), the licensee assumed a quarter-thickness semielliptical surface flaw with an aspect ratio of 6:1 oriented along the weld of concern. The applied J value due to a pressure of 1.15 times the accumulation pressure was calculated and added to the J value that corresponds to a thermal gradient loading due to a cooldown rate of 100 °F/hour. The combined J value at 0.1 inch crack extension, $J_{0.1\ APP}$ (487.5 in-lb/in^2), was then compared to the mean minus two sigma J value at the same crack extension, $J_{0.1\ MAT}$ (548.4 in-lb/in^2), obtained by using the copper-fluence model developed for the B&WOG by Eason et al. [1]. The first criterion, which requires $J_{0.1\ APP} < J_{0.1\ MAT}$, was clearly satisfied.

Further, the licensee demonstrated that under the combined loads of pressure of 1.25 times the accumulation pressure and the thermal gradient load, the slope of the applied J curve is smaller than the slope of the material J curve at the intersection. Consequently, the second criterion, which requires $(dJ/da)_{INT\ APP} < (dJ/da)_{INT\ MAT}$, is satisfied.

Unlike the J-R models in NUREG/CR-5729 [4], which were derived from a larger material database, the licensee generated the J-R curves from a data subset consisting of data from B&W fabricated vessels. The contractor, Oak Ridge National Laboratory (ORNL), indicates in the technical evaluation report (TER) [5] that it made a comparison between the J-R curves from this model and those from the NRC copper-fluence model [4], and found that the B&WOG's J-R model is more conservative for fluences below 10^{19} n/cm^2. This extra margin is applicable to the Zion vessels because the projected end-of-life (EOL), 32 effective full power years (EFPY), fluence for the axial welds of the vessels is 3.26×10^{18} n/cm^2, not the conservative value of 9.34×10^{18} n/cm^2 used by the B&WOG in the analysis. The TER indicates that the Zion vessels meet, by a small margin, the criteria contained in ASME Code Case N-512 after considering the variability of copper contents for WF-70 welds and the possible presence of an Atypical weld in the Zion vessels.

Atypical weld refers to a Linde 80 weld (wire heat no. 72105) with an atypical concentration of copper, nickel, and silicon, which was discovered in the second surveillance block in Crystal River 3 plant. This type of weld was evaluated in the SER for topical report, BAW-10144-A [6], entitled "Evaluation of the Atypical Weldment." This SER concluded that the probability that atypical weld metal was used in fabricating the 12 B&W vessels is very low.

The staff has verified independently the bounding nature of the axial welds. The $J_{0.1\ APP}$ calculated by the B&WOG is 487.5 in-lb/in^2; the corresponding $J_{0.1\ APP}$ calculated by the staff for the circumferential weld, after considering the reduction in one half of the nominal stress due to pressure, is approximately 168.5 in-lb/in^2, a reduction of 65.4%. On the other hand, the staff found from Figure 6 of the TER that the drop in $J_{0.1\ MAT}$ caused by adjusting the fluence value from 3.26×10^{18} n/cm^2 to 9.34×10^{18} n/cm^2 is only 7.0%. Therefore, the axial weld evaluation bounds the case for circumferential welds.

Based on the copper content of 0.35% reported by the licensee, the currently projected fluence value of 3.26×10^{18} n/cm^2 for the axial welds (9.34×10^{18} n/cm^2 for the circumferential welds), the normal operating temperature of 530 °F, and the NRC conclusion on the issue of Atypical weld in [6], the staff has concluded that the Zion welds will have adequate margins for Level A and B conditions until the EOL.

3.0 CONCLUSION

The staff has completed the review of the TER and approves the submittal based on the TER by ORNL. The staff concludes that Zion, Units 1 and 2 reactor pressure vessels have adequate margins of safety against ductile tearing in beltline welds until the EOL (32 EFPY) for Level A and B conditions, and meet the criteria for Level A and B conditions contained in the ASME Code Case N-512. Although this report did not evaluate plate material, the information submitted in response to Generic Letter (GL) 92-01 indicates that all beltline plates of Zion vessels have EOL USE values above 50 ft-lb. This information will be confirmed as part of the staff's GL 92-01 review.

The staff's review of the topical report BAW-2178P "Low Upper-Shelf Toughness Fracture Mechanics Analysis for Level C & D Loads" is also complete, however, there are further licensee actions required to apply BAW-2178P to the Zion Nuclear Power Station, Units 1 and 2 reactor vessels which are addressed in separate correspondence. Although a preliminary analysis [7], indicates that Level A and B conditions are controlling, a final determination regarding the Zion 1 and 2 reactor vessels having margins of safety against fracture equivalent to those required by Appendix G of ASME Code Section III for all levels (A, B, C, and D) will be made as soon as these other actions are complete.

4.0 REFERENCES

1. BAW-2148P, Rev. 1, "Low Upper-Shelf Toughness Fracture Analysis of Reactor Vessels of Zion Units 1 and 2 for Load Level A & B Conditions," B&W Nuclear Service Company, April 1992 (proprietary).

2. Responses to RAI on BAW-2148P, Rev. 1, B&W Nuclear Service Company, July 29, 1993.

3. Code Case N-512, "Assessment of Reactor Vessels with Low Upper Shelf Charpy Impact Energy Levels, Section XI, Division 1," ASME Boiler and Pressure Vessel Code, February 12, 1993.

4. E. D. Eason, J. E. Wright, and E. E. Nelson, "Multivariable Modeling of Pressure Vessel and Piping J-R Data," NUREG/CR-5729, May 1991.

5. J. G. Merkle and D. K. M. Shum, "Technical Evaluation Report (TER) Review of BAW-2148P, Rev. 1, Low Upper-Shelf Toughness Fracture Analysis of Reactor Vessels of Zion Units 1 and 2 for Load Level A & B Conditions," Oak Ridge National Laboratory, December 7, 1993.

6. K. E. Moore, A. L. Lowe, Jr., C. E. Harris, R. R. Seeley, and E. S. Robitz, "Evaluation of the Atypical Weldment," Topical Report: BAW-10144-A, October 11, 1993.

7. B&W Owners Group letter dated September 10, 1992 "Appendix G Analysis for B&W Owners Group Reactor Vessel Working Group Plants."

Principal Contributor: S. Sheng

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