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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 2

FLAW EVALUATION RELATED TO PRESSURIZER INSTRUMENT NOZZLE REPAIR

BALTIMORE GAS AND ELECTRIC COMPANY

DOCKET NO. 50-318

1.0 INTRODUCTION

By letter dated August 4, 1998, the Baltimore Gas and Electric Company (the licensee) submitted, for NRC review, its flaw tolerance evaluation for an assumed flaw in the inboard instrument weld of the pressurizer for Calvert Cliffs Nuclear Power Plant, Unit 2. During a walkdown while Unit 2 was in hot standby (Mode 3), the licensee detected leakage from the pressurizer upper level tap (instrument nozzle 2-LT-110-X). As a result, the licensee performed ultrasonic (UT) examination of the pressurizer vessel shell. The inspection results showed no defects in the vessel shell. However, no UT examination was performed on the weld of the pressurizer instrument nozzle. In the subsequent repair, the licensee welded the outboard portion of the nozzle to a weld pad on the outside of the pressurizer head to form a new pressure boundary for the coolant. No repair of the inboard instrument weld where the leakage was identified was performed. Instead, the licensee utilized the evaluation procedure and criteria in Appendix A of Section XI of the American Society of Engineers (ASME) Code to demonstrate that the assumed crack is acceptable without repair for the design life of the vessel which includes 500 heatups and cooldowns.

2.0 EVALUATION

2.1 Licensee Evaluation

The licensee did not perform UT examination on the inboard instrument weld that was suspected of having flaws. As a result, the licensee postulated a quarter-circular flaw at the inside corner of the pressurizer upper head penetration. The crack face starts at the inside surface of the base metal and includes the J-groove area. To bound the analysis, the licensee assumed the maximum flaw depth (1.0625 inches) that could exist in the weld, i.e., a depth equivalent to the height of the J-grooved weld. This crack was grown due to the fatigue crack growth caused by heatups and cooldowns. The fatigue growth rate was based on the Appendix A curve for surface flaws under the water reactor environment. A formula from EPRI NP-719-SR, "Flaw Evaluation Procedures: ASME Section XI," prepared by ASME, was used to calculate the applied stress intensity factor (applied K) for the flaw. In this process, the licensee has applied stress concentration factors to the applied stresses: 2.0 to account for the hole (nozzle penetration) and 1.2 to account for the effect of having an oblique nozzle penetration. Further, Irwin's plasticity correction was applied to adjust the crack length to account for a moderate amount of yielding at the crack tip.

On the fracture resistance side, the licensee estimated the crack arrest fracture toughness, K_{Ia}, using the lower bound ASME curve for an operating temperature of 653° and an RT_{NDT} of 40 °F for the pressurizer upper head material. The licensee compared the K_{Ia} with the applied K using the acceptance criterion of IWB-3612 for normal and upset conditions, and found it takes 2616 cycles (more than 5 times the 40-year design cycles) for the initial crack to reach the critical size of 1.71 inches. Hence, the licensee concluded that the unrepaired crack in the inboard instrument weld "does not present a challenge to the long term structural integrity of the shell."

2.2 NRC Staff Evaluation

The staff has reviewed the licensee's flaw tolerance evaluation and determined the evaluation is in accordance with the procedure and criteria in Appendix A, and therefore, is acceptable. The analytical results further indicate that in addition to the margin of $(10)^{½}$ in the applied K specified in the ASME Code, there is an extra margin contained implicitly in the large number of heatup and cooldown cycles (2616 cycles versus the design cycles of 500) needed to reach the critical flaw depth. The staff determined that this extra margin is sufficient to account for the uncertainty caused by using the applied K formula from EPRI NP-719-SR and by using the analytically derived formulas in estimating the stress concentration factors for the nozzle penetration and for the effect of having an oblique penetration. Hence, the pressurizer of Calvert Cliffs Unit 2 should be able to operate with a flaw in the instrument weld.

In response to the staff's concern over monitoring the crack growth, the licensee indicated in a letter dated August 25, 1998, that it will perform an inspection in the next outage and will make the results of the inspection available to the NRC. In addition, the licensee is committed to provide an action plan for the long-term inspection of the pressurizer instrument nozzle weld flaw by February 26, 1999. The staff will review submitted information at that time and determine whether the unit can be operated with a flaw in the instrument weld to the expiration of the license.

3.0 CONCLUSION

The staff completed the review and concluded that the flaw tolerance evaluation meets the rules of the ASME Code. Since the predicted number of heatups and cooldowns needed to reach the allowable flaw depth (1.71 inches) is far greater than the design cycles, the staff concluded that the pressurizer of Calvert Cliffs Unit 2 should be able to operate with a flaw in the instrument weld. The staff will review the action plan for inspection and the information regarding the inspection results during the next outage to evaluate whether the pressurizer can be operated with a flaw in the instrument weld to the expiration of the license.

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Date: October 5, 1998