UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING STEAM GENERATOR 2C GIRTH WELD INDICATION

ALABAMA POWER COMPANY

JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-364

1.0 INTRODUCTION

In a letter dated November 20, 1990, the Alabama Power Company (the licensee) submitted the results of ultrasonic examination and fracture mechanics analysis of a flaw in the 2C steam genera' r upper transition cone-to-shell weld for staff review and approval. The acceptance standards for a flaw in this weld are contained in Table IWB-3410-1 of the American Society of Mechanical Engineers, Boiler and Presssure Vessel Code (ASME Code), Section XI. (1983 Edition with the Summer 1983 Addenda). Sub-paragraph IWB-3122.4 indicates that components with flaws exceeding the standards in Table IWB-3410-1 shall be acceptable for service if an analytical evaluation meets the acceptance criteria in IWB-3600. IWB-3600 requires the licensee to perform a fracture mechanics analysis. The licensee's fracture mechanics analysis is documented in WCAP-12211 (proprietary) and WCAP-12447 (non-proprietary), "Background and Technical Basis: Handbook on Flaw Evaluation for the Farley Units 1 & 2 Main Coolant System and Components," September 1989; and WCAP-12213, Revision 1, "Handbook on Flaw Evaluation for Joseph Farley Units 1 and 2 Steam Generators and Pressurizers," July 1990, which were submitted as attachments to the November 20, 1990, letter.

2. EVALUATION

The licensee's ultrasonic examination revealed one indication that exceeded the acceptance standards in Table IWB-3410-1. The examination revealed that the flaw was 4.0 inches long, 0.35 inches in depth and had its leading edge 0.46 inches from the inside surface of the vessel. According to the ASME Code criteria, this indication is considered to be an embedded reflector. Based on its location, the licensee concluded that the indication was a series of small weld inclusions and/or voids resulting from fabrication. The inside surface of the weld was visually examined. Neither this flaw nor any other deleterious indication (pitting or cracking) was observed. In lieu of excavation and weld repair of the flaw, the licensee proposed to demonstrate by using fracture mechanics analysis that the flaw is acceptable. The licensee, in Appendix A to WCAP-12213, has provided flaw evaluation charts for welds in the Farley, Unit 2, pressurizer and steam generator. These charts were constructed using fracture mechanics analyses. The method and criteria used in the

3

fracture mechanics analyses are documented in WCAP-12211. The fracture mechanics analyses that were performed to develop the flaw evaluation charts were in accordance with the methodology and criteria specified in paragraph IWB-3600 and Appendix A of the ASME Code, Section XI, except that stresses were not linearized and stress intensity factors were not calculated in accordance with the recommendations in Appendix A. In lieu of linearizing the stress, the method used represented the actual stress profile by a cubic polynomial. Stress intensity factors were calculated using formulae that are reported in various published engineering literature. These stress profiles and stress intensity factor expressions are believed to provide a more accurate determination of the critical flaw size, and are particularly important during the evaluation of emergency and faulted conditions where the stress profile is generally nonlinear and often very steep.

Important parameters in a fracture mechanics analysis are the materials' brittle fracture resistance and the projected flaw growth rate during operation of the component. The standard measurement of brittle fracture resistance for the vessel materials in the Farley, Unit 2, pressurizer and steam generator are their crack initiation and arrest fracture toughness. These values of fracture toughness are used to determine a critical flaw size. The licensee indicates that the critical flaw size calculation used the crack initiation and arrest fracture toughness for vessel materials that are recommended in Appendix A of the ASME Code, Section XI. The critical flaw size for each weld location was determined using a reference temperature based on Charpy energy test results at 10°F and an upper shelf toughness of 200 ksi.in$^{1/2}$. These values are acceptable for the steam generator and pressurizer welds since the weld material in these components is not subject to neutron irradiation damage.

The amount of projected flaw growth was calculated using the transients reported in Table 2-2 of WCAP-12211 and the rate of fatigue growth recommended in Appendix A of Section XI of the ASME Code. The rates of fatigue growth documented in Appendix A are for surface flaws in a water reactor environment and subsurface flaws in an air environment, but are not for accelerated growth due to stress corrosion or thermal stratification mechanisms.

The staff believes that stress corrosion and thermal stratification should not be a problem for the flaw in the steam generator because it is located 0.46 inches from the inside surface of the vessel. Hence, it will not be in contact with a corrosive environment and will not be subjected to a stress corrosion or thermal stratification mechanism.

Components that are acceptable for service based on fracture mechanics analysis must be re-examined to determine whether there has been significant growth of the flaw during service. The staff recommends that the flaw in the steam generator upper transition cone-to-shell weld be re-examined in accordance with sub-paragraph IWC-2420(b) and (c) of ASME Code, Section XI (1986 Edition). The licensee, in a telephone call with the staff on December 5, 1990, agreed to the staff's recommendation.

Based on the location and depth determined by ultrasonic examination, the flaw evaluation charts in Appendix A of WCAP-12213 indicate that the flaw in the Farley, Unit 2, steam generator is acceptable per analytical criteria of IWB-3600 of Section XI of the ASME Code, Section XI, and that future component hydrotest must be performed at temperatures greater than 130°F. The licensee has not agreed to perform future hydrotests for the secondary side of the steam generator at this temperature. Since the next hydrotest is not scheduled until the next refueling outage, the hydrotest temperature is an issue that the licensee must address and submit for staff review prior to the next refueling outage.

3.0 CONCLUSION

1) The flaw that exceeds the standards of Table IWB-3410-1 of Section XI of the ASME Code in the 2C steam generator is most likely slag inclusions resulting from weld fabrication.

2) Excavation and weld repair of this flaw would not increase the level of quality and safety of the components.

3) The fracture mechanics evaluations that are illustrated in the charts in WCAP-12211 and WCAP-12213 demonstrate that the flaws will meet the acceptance criteria in IWB-3600 of ASME Code, Section XI, and will not grow to a size that will affect the integrity of the component during the life of the plant.

4) The proposed alternative provides an acceptable level of quality and safety, provided the flaw is re-examined in accordance with sub-paragraph IWC-2420(b) and (c) of ASME Code, Section XI, (1986 Edition) and future hydrotests are performed at temperatures greater than 130°F.

5) Based on (1) the fracture mechanics evaluation, (2) the licensee commitment to re-examine the flaw in accordance with sub-paragraph IWC-2420(b) and (c), and (3) the licensee commitment to address the hydrotest temperature issue prior to the next refueling outage, the licensee may be permitted to place the Farley, Unit 2, 2C steam generator into service without excavation and weld repair of the flaw that exceeds the acceptance criteria in Table IWB-3410-1.

Dated: December 13, 1990

Principle Contributor: B. Elliot