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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FLAW EVALUATION OF A CORE SPRAY HEADER WELD

COMMONWEALTH EDISON COMPANY

AND

IOWA-ILLINOIS GAS AND ELECTRIC COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNIT 1

DOCKET NO. 50-254

1.0 INTRODUCTION

During the current refueling outage (Q1R13) at Quad Cities, Unit 1, a crack estimated to be 7 inches in length was visually found in the heat affected zone of a weld joining the piping and the junction (tee) box in the "B" Core Spray header. The junction box and the associated piping located in the annulus outside the shroud directs core spray flow from the vessel inlet nozzle to the spargers inside the shroud. The core spray piping and sparger system consists of safety related components which provide emergency coolant to the core.

Commonwealth Edison (ComEd, the licensee) had initially planned to repair the core spray header weld by manually installing a mechanical clamp at the cracked location. However, the dosage associated with this manual repair was estimated to be at least 12 rem. Subsequently, ComEd proposed to repair the subject weld during the next refueling outage in order to allow time to investigate the option of installing the mechanical clamp remotely for minimizing personnel exposure. ComEd's flaw evaluation is provided in their submittals dated June 17 and July 14, 1994. ComEd concluded in their evaluation that adequate core cooling will be provided by the core spray piping and sparger system during the operation of the next fuel cycle with the existing flaw in the "B" core spray header weld.

2.0 EVALUATION

The licensee has determined that the observed crack in the "B" core spray header weld was most likely caused by intergranular stress corrosion cracking (IGSCC). This determination is based on the characteristics and location of the crack as well as the high carbon content of the stainless steel material.

ComEd performed a structural analysis and concluded that the structural integrity of the core spray header weld will be maintained for all conditions of operation over the next operating cycle. This conclusion is based on the following considerations:

(1) Using a bounding crack growth rate of 5×10^{-5} inches/hour the final crack length at the end of the next fuel cycle (18 months) will be 8.4 inches, approximately 150° of the pipe circumference.

(2) Based on a limit load analysis, the core spray pipe can tolerate a through-wall crack of up to 240° of pipe circumference.

The staff does not agree with ComEd's crack growth calculation because its calculation was based on a crack length of 7 inches which was visually observed on the outside diameter (OD) surface. The use of OD crack length in the flaw evaluation is not conservative because most likely the IGSCC initiated from the inside diameter surface and, depending on aspect ratio, the total length could be much longer than the portion that is showing on the outside surface of the pipe. Furthermore, if multiple cracks initiated at the inner surface, the total final crack length could be substantially longer than 8.4 inches.

ComEd also performed an evaluation and concluded that when the crack reaches 180° of the pipe circumference, the displacement controlled stresses would almost be completely relieved and further crack growth would not be significant. Although there is some merit in this argument, the result of the evaluation is not verified or supported by component testing.

In view of the staff's concerns, a conference call was held on July 7, 1994, and the staff requested ComEd to estimate the leakage from a 360° through-wall crack at the "B" core spray header weld and discuss its safety consequences. ComEd's leakage estimation and safety discussion were documented in their submittal dated July 14, 1994. ComEd indicated that the crack opening is limited by a clamp near the crack that restrains the pipe movement in the circumferential direction. Based on ComEd's estimation, the resulting leakage from a postulated 360° through-wall crack would be expected to be about 656 gpm. ComEd's LOCA analysis showed an increase in peak cladding temperature (PCT) of 110°F which does not result in a violation of 10 CFR 50.46 limits and is acceptable.

ComEd has concluded that lost parts (loose pieces) in the reactor from the core spray header are not expected. Further, cracking at similar piping location was reported at several other operating BWRs, and no loose parts were found. This result indicates that the generation of loose parts from this piping location during the next fuel cycle is not expected.

3.0 CONCLUSION

Based on our review of ComEd's evaluation, the staff concludes that Quad Cities Unit 1 can be safely operated during the next operating cycle (Cycle 14). To ensure continued safe operation of Quad Cities Unit 1, the cracked "B" core spray header weld should be repaired at the next refueling outage.

Principal Contributor: W. Koo

Date: August 4, 1994