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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO CRACKS IN THE CORE SPRAY SPARGER AND PIPING

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

DOCKET NOS. 50-325 AND 50-324

1.0 INTRODUCTION

In a letter dated September 13, 1991, Carolina Power & Light Company (the licensee) submitted a summary of the intended repair technique for the crack found in the reactor vessel internal piping adjacent to the tee-box on the north core spray line (header) of the Brunswick Steam Electric Plant (BSEP), Unit 2. The licensee also indicated the intention to discontinue the liquid penetrant inspection and reporting of additional crack growth in the weld following repair. The licensee submitted a letter, dated November 27, 1991, to document the repair and provide the supporting safety evaluation, and to justify discontinuing the liquid penetrant inspection and reporting of additional crack growth for the remainder of the operating life for Brunswick, Unit 2.

On July 26, 1993, the licensee submitted its analysis of the two cracks observed in the loop B core spray sparger for BSEP, Unit 1. A 3-inch long circumferential crack was found in the heat affected zone (HAZ) of a tee-to-sparger arm weld on one of the lower loop B spargers, and a 4-inch long crack was found in the HAZ of a weld located in the in-vessel piping between the loop B inlet nozzle and the sparger about 18 inches downstream from the loop B tee box. Based on its analysis, the licensee concluded that the core spray piping was acceptable for the next operating cycle. The piping will be examined, re-evaluated and/or repaired during the BSEP, Unit 1, Refueling Outage No. 9 (Cycle 10).

2.0 DISCUSSION

Unit 2

In a letter dated June 5, 1991, the NRC staff stated that the licensee's conclusion to allow Brunswick, Unit 2, to continue to operate through fuel Cycle 9, with a cracked core spray line inside the reactor vessel, were acceptable. The staff indicated that the licensee should repair the piping during the Cycle 9 refueling outage.

The licensee submitted a summary, dated September 13, 1991, of the intended repair technique, which was to be performed under the provisions of 10 CFR 50.59. Following the repair, in a letter dated November 27, 1991, the licensee submitted the results of the remote visual examination, a description of the repair technique, and the safety evaluation performed on the modified core spray line.

The north core spray line was repaired by reinforcing the piping using underwater welding techniques to weld a bracket assembly to the core spray piping. The bracket assembly covered the cracked tee-box location and consisted of an upper and lower bracket welded across the piping arms and tee-box. The design of the brackets was intended to maintain full structural integrity of the core spray piping, even if cracks propagate through the entire cross section of the pipe. In addition, the bracket material and weld filler material are both resistant to intergranular stress corrosion cracking (IGSCC), which is the suspected cause of the existing cracking. The underwater welding was performed in accordance with the guidance of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section IX, and the American Welding Society Specification for Underwater Welding, ANSI/AWS D3.6-89. The licensee's repair method was compared to that used at Peach Bottom (PB), Unit 3, for a similar indication on the core spray system, which was previously reviewed and accepted by the staff. The repair method was found to be consistent with PBs with only minor differences.

A safety evaluation was performed by the licensee on the modified core spray line to support continued operation in the upcoming fuel cycles. The evaluation consisted of a crack leakage estimate review, core spray pipe structural integrity review, lost part analysis review, and a loss-of-coolant accident analysis review. The licensee concluded that continued operation with the core spray line indications and addition of brackets does not constitute an unreviewed safety question or a significant safety hazard. The NRC staff reviewed the safety evaluation and concluded that the brackets would maintain full structural integrity and support continued operability of the core spray line.

Following the repair, a remote visual examination was performed on the brackets. Based on the examination results, the licensee justified continued operation to the next refueling outage. The licensee stated that during future refueling outages the liquid penetrant inspection would be performed on the bracket welds, instead of the cracked piping welds due to the fact that the brackets are what support continued operability of the core spray line. The licensee indicated a visual inspection would continue to be conducted on the cracked weld. The staff concurs with the licensee's proposal to discontinue the liquid penetrant inspection of the circumferential cracked weld, substituting instead liquid penetrant of the bracket welds, but requests that the licensee continue to report the results of the visual inspection (i.e., any additional crack growth) of the cracked weld through the next two refueling outages.

Unit 1

The licensee submitted a core spray crack analysis for BSEP, Unit 1, on July 26, 1993. The licensee estimated leakage, evaluated the structural integrity of the line and sparger, and addressed the possibility of loose parts and effects on ECCS performance. The licensee concluded that the BSEP Unit 1 core spray piping is acceptable in the as-found condition for operation during the next operating cycle. Depending on

the examination results during the next refueling, the licensee will re-evaluate and/or repair the core spray piping,

Reviewing the licensee's analysis, the staff finds that the assumptions of crack size and the estimate of possible leakage during the operation of the core spray system is sufficiently conservative. The method used to find the cracks was visual examination with a remotely controlled underwater camera. Therefore, the reported lengths apply to measurements on the outer diameter of the pipe. The cause of the cracking being intergranular stress corrosion, cracks can be expected to be longer on the inner diameter and to grow. GE analyzed the cracks for the licensee, accounting for the probable differences in lengths on the inner and outer diameters. For the crack estimated be 4 inches in length, GE conservatively assumed a 180 degree through wall crack (about 8.3" long) and estimated the bounding leakage rate. The maximum leakage was calculated to be about 8 GPM. For the 3 inch crack, also assumed to be 180 degrees long and through wall, the maximum leakage would be about 3 GPM. A length of 180 degrees was chosen as a conservative value because stress analyses show that this value is the upper bound for crack arrest.

Even though the cracks are expected to be virtually arrested at 180 degrees, GE determined the maximum acceptable circumferential through-wall flaw. This analysis provides an assessment of the safety margin of the line from primary loads. The results showed that a through-wall crack of up to 240 degrees around the circumference would not cause a failure of the core spray line, and a crack of up to 220 degrees would not cause failure of the sparger. These lengths are much greater than the maximum estimated crack lengths at the end of the next fuel cycle, 5.2 inches for the core spray line and 4.1 inches for the sparger. GE concluded that the structural integrity of the core spray line and sparger with cracks will be maintained for all conditions of normal operation for the next operating cycle.

A through-wall crack of 360 degrees is improbable, but GE performed a structural analysis to determine its effect. It concluded that the sparger would lose no pieces and would remain attached to the shroud wall.

The staff reviewed the licensee's evaluation for the effect of a possible core spray line or sparger crack on the emergency core cooling performance during accidents. The combined leakage from a possible through-wall crack appears to be well within the bounding margin used in the assumptions for the core spray system. Therefore, the staff finds acceptable the licensee's conclusion that this leakage would have a negligible effect on core spray performance and accident response.

3.0 CONCLUSIONS

The staff has concluded that the core spray systems for BSEP, Units 1 and 2, are acceptable for continued operation through to the next refueling outage. Continued operation of the Unit 2 repaired core spray

sparger beyond the next fuel cycle will depend on the satisfactory evaluation of the inspection results performed during the next refueling outage and the continued effectiveness of the reinforcing welded brackets. Similarly, continued operation of the Unit 1 core spray sparger and piping beyond the next fuel cycle will also depend on the satisfactory evaluation of the inspection results during the next refueling outage. The licensee is requested to provide the results of these inspections and evaluations to the NRC staff should the licensee determine that a permanent rework of the sparger or piping not be needed during the next outage for either unit.

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