UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CORE SPRAY INTERNAL PIPING FLAW EVALUATION

NEBRASKA PUBLIC POWER DISTRICT

COOPER NUCLEAR STATION

DOCKET NO. 50-298

1.0 INTRODUCTION

By letter dated November 22, 1995, the Nebraska Public Power District (the licensee) submitted a flaw evaluation report for NRC review and approval. Additional information was supplied in a letter dated December 18, 1995. These reports contain the licensee's evaluation of flaw indications in the core spray internal piping. The indications were identified by General Electric's (GE's) In-Vessel Inspection personnel. Ultrasonic (UT) examinations were conducted to size these indications. The inspection was performed to satisfy the requirements of NRC IE Bulletin 80-13, "Cracking in Core Spray Spargers." The subject bulletin requires all operating licensees of boiling water reactors (BWRs) to perform a visual inspection of the core spray spargers and the segment of piping between the inlet nozzle and the vessel shroud every refueling outage. The ultrasonic examinations were performed in accordance with the requirements of American Society of Mechanical Engineers (ASME) Code, Section XI, 1989 Edition.

2.0 EVALUATION

Circumferential flaws were found in the heat affected zones (HAZ) of three core spray internal piping welds. The indications exceeded the acceptance criteria in IWB-3514 of ASME Section XI. The licensee performed flaw evaluations to support continued plant operation for another fuel cycle without repairing the subject flawed welds. The licensee also stated in its submittal that the subject flawed welds will be re-inspected in accordance with IE Bulletin 80-13 during each refueling outage.

The techniques used both in the in-vessel visual inspection (IVVI) and UT examinations led to conservative flaw length determinations. An indication was found on the thermal sleeve of Loop A (in the HAZ of weld #1) with an estimated length of 8.9 inches. A second indication was found on the second thermal sleeve of Loop A (in the HAZ of weld #21) with an estimated length of 5.5 inches. The third indication was found on the pipe side near the tee box of Loop B (HAZ of weld #12) with an estimated length of 1.5 inches.

The nominal pipe wall thickness is 5/32 inches (0.156 inches). Although the flaws were verified by UT to be part through-wall, and not connected to the inside diameter (ID) surface, the licensee conservatively assumed these to be through-wall flaws during flaw evaluations. The cause of the existing flaws is intergranular stress corrosion cracking (IGSCC).

The licensee calculated the critical flaw sizes using the methodologies and the acceptance criteria provided in IWB-3640 and Appendix C of ASME Boiler and Pressure Vessel Code, Section XI. The acceptance criteria were for flaws in materials fabricated by gas tungsten arc welding (GTAW) because the flaws were located in the HAZ of the gas tungsten arc fabricated welds. A safety factor of 2.8 was applied to the bounding load combination of pressure, weight, thermal and seismic loads. The licensee calculated the values of stresses and critical flaw sizes for the normal/upset and the emergency/faulted operating conditions. The normal/upset condition was determined to be the limiting operating condition.

The licensee used the ANSYS code to create a finite element model of one loop of the internal core spray piping in order to determine the membrane and bending stresses. The design loads considered were: 1) an internal pressure that is representative of a simultaneous occurrence of core spray operation and the seismic operating basis earthquake (OBE), 2) the weight of the contained water, 3) seismic analyses of the reactor pressure vessel, and 4) thermal displacement analyses. The membrane and bending stresses for the upset condition are considered to be conservative because the licensee assumed that the core spray operation and the seismic OBE event occur at the same time.

The licensee assumed a conservative crack growth rate of 5×10^{-5} inches/hour (with growth occurring from both ends of the crack, for an additional factor of 2) and 12,000 hours of operation, in calculating a maximum crack length increase of 1.2 inches. This assumed crack growth rate is intended to model the rate of crack growth for IGSCC of core spray line material (Type 304 stainless steel). The results of the licensee's crack growth calculations show that after an 18 month fuel cycle, all projected lengths are less than the allowable flaw lengths. With the assumption of through-wall flaws and the conservative crack growth rate, sufficient margin exists to account for operation through the next fuel cycle.

The allowable flaw size for the indication near weld #1 in Loop A was calculated to be 11.8 inches in length, the allowable value for the indication near weld #21 in Loop A was also 11.8 inches in length, and the allowable value for the indication near weld #12 in Loop B was calculated to be 10.7 inches in length. The staff has verified the calculation of allowable flaw length during the review of the licensee's flaw evaluation, and finds the results to be acceptable to support the safe operation of CNS for the next fuel cycle without repairing the subject flawed welds.

Since the flaws are assumed to be through-wall flaws, there is concern regarding the potential leakage from these flaws. Although the staff expects the potential leakage to be very small relative to the available core spray flow, (because the IGSCC cracks are generally very tight and the core spray design flow rate for each loop is approximately 4720 gpm); it is prudent to perform an evaluation to ensure that adequate core spray flow would be maintained for core cooling. In addition, as the IGSCC cracks are branching in nature, pipe pieces of various sizes may come apart after extensive crack growth. To ensure long-term safe plant operation, the licensee should also evaluate the potential safety consequences of these loose parts as well as the plant capability of detecting and removing such loose parts. The staff has previously reviewed an evaluation of the potential impact of core spray flow leakage and loose parts for a similar plant (Brunswick), and no safety consequences were identified. However, the licensee should perform similar confirmatory evaluations for CNS and submit the evaluations for NRC review no later than three months after plant restart.

3.0 CONCLUSION

Based on the review of the licensee's submittal, the staff concludes that the structural integrity of the core spray internal piping will be maintained, and the indications in the core spray internal piping are acceptable for continued operation through the next fuel cycle without repair. Continued operation beyond the next fuel cycle will depend on the satisfactory evaluation of the inspection results performed during the next refueling outage.

4.0 REFERENCES

1. ASME Boiler and Pressure Vessel Code, Section XI-Division 1, Appendix C, "Evaluation of Flaws in Austenitic Piping," 1992.

2. IE Bulletin 80-13, "Cracking in Core Spray Spargers," May 12, 1980.

3. Nebraska Public Power District, letter from J. Mueller to USNRC Document Control Desk, "IE Bulletin 80-13 Response; Visual Inspection of Core Spray Spargers Cooper Nuclear Station," November 22, 1995.

4. USNRC, NUREG-0313, Revision 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," January 1988.

5. GE Report GENE-523-A121-1195, DRF # 137-0010-8, "Internal Core Spray Line Flaw Evaluation at Cooper Nuclear Station," November 1995.

6. January 14, 1994, Letter from P. D. Milano to R. A. Anderson Subject: Examination and Evaluation of Core Spray Sparger and Piping Cracks-Brunswick Steam Electric Plant, Units 1 and 2.

7. Nebraska Public Power District, letter from J. Mueller to USNRC Document Control Desk, "Follow-up Information to IE Bulletin 80-13 Response; Visual Inspection of Core Spray Spargers, Cooper Nuclear Station," December 18, 1995.

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