50-324

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

January 18, 1996

Mr. W. R. Campbell
Vice President
Carolina Power & Light Company
Brunswick Steam Electric Plant
Post Office Box 10429
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SUBJECT: APPROVAL OF REVISED PLANS FOR REPLACEMENT OF FEEDWATER SPARGERS, AND DEFERMENT OF FEEDWATER NOZZLE EXAMINATIONS - BRUNSWICK STEAM ELECTRIC PLANT, UNIT 2 (TAC NOS. M93547 AND M93820)

Dear Mr. Campbell:

In a letter dated August 17, 1995 (Ref. 1), as supplemented on January 10, 1996, Carolina Power & Light Company (CP&L) notified the U.S. Nuclear Regulatory Commission (NRC) that its plan to replace the Brunswick Steam Electric Plant (BSEP), Unit 2, feedwater spargers during refueling outage 11 (B212R1), which is scheduled to begin on February 2, 1996, has been modified. Based on the satisfactory results of previous Unit 2 sparger examinations, CP&L stated that it no longer plans to replace the spargers. Instead, CP&L has committed to continue performing sparger examinations every refueling cycle. CP&L will employ a visual technique (VT) utilizing a high-resolution underwater camera to conduct these examinations, as approved by the NRC on March 16, 1995 (Ref. 2).

BSEP, Unit 2, utilizes interference-fit spargers in clad feedwater nozzles. The NRC has approved a similar proposal for BSEP, Unit 1, to perform continuing inspections in lieu of sparger replacement (Ref. 2). BSEP, Unit 1, utilizes welded spargers in clad feedwater nozzles.

In a letter to the NRC dated October 9, 1995 (Ref. 3), as supplemented on January 10, 1996, CP&L requested a deferral for one refueling cycle of the liquid penetrant (LP) examination of the inner blend radii of the Unit 2 feedwater nozzles. These examinations have been conducted once every two refueling cycles in accordance with the schedule described in Table 2 of NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking." Conformance with that schedule would currently require that the next LP examinations be performed during the upcoming Unit 2 refueling outage 11. CP&L requested the deferral based upon the performance of an enhanced ultrasonic examination (UT) of the feedwater nozzles in conjuction with a VT examination of the inner blend radii of the feedwater nozzles during refueling outage 11 (B212R1). The deferral will allow additional time to complete qualification of the enhanced UT procedure. Once that procedure is qualified, CP&L may request NRC approval to use enhanced UT in lieu of the LP examinations for future inspections of the inner blend radii. The request for deferral was also based upon the hardship posed by the personnel exposure (approximately 5.3 person-rems) that would be incurred by performance of the LP examinations.

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A discussion is provided below of previous Unit 2 feedwater sparger and nozzle examination results and related engineering analyses.

Feedwater Spargers

A sparger circumferential weld crack (on the 225° sparger) was initially identified on Unit 2 by LP examination during refueling outage 7 (B208R1) in 1988. LP examinations during refueling outage 8 (B209R1) in 1989/1990 showed no significant growth in the crack on the 225° sparger and identified a circumferential weld crack on the 135° sparger. UT and LP examinations during refueling outage 9 (B210R1) in 1991 identified indications in the circumferential welds on the 45°, 135°, and 225° spargers. The refueling outage 9 UT examinations confirmed that no crack extended beyond the length of its observed LP indication.

On December 21, 1994 (Ref. 4), CP&L submitted the results of the non-destructive examination (NDE) of the feedwater spargers performed during the spring 1994 refueling outage 10 (B211R1). The NDE encompassed VT of the eight circumferential welds joining the sparger arms to the tees and all the flow holes to the extent possible using an underwater, high resolution, remote-operated camera. The examination determined that the circumferential weld cracks were in the same condition as found through UT and LP examinations during refueling outage 9 (B210R1). All of the existing cracks were on the flow hole side of the spargers. The cracks extended downward following the heat affected zone (HAZ) of the circumferential welds. There was no appreciable change in the length or number of cracks. The longest existing crack found was on the 135° sparger and measured 2 inches at the outside diameter (OD).

A General Electric Company (GE) analysis provided to the NRC on July 27, 1992 (Ref. 5), showed that the critical crack size is 14.1 inches on the outside of a sparger circumferential weld and determined that the maximum crack growth for a circumferential weld over a refueling cycle is 3.16 inches. Based upon this maximum crack growth rate, the longest Unit 2 circumferential crack at the end of the present operating cycle would be 5.16 inches and 8.32 inches at the end of the next operating cycle.

Refueling outage 10 sparger flow hole VT examination results, when compared to refueling outage 9 LP examination results, showed that the flow holes continued to experience slow crack growth. Some new cracking was seen around the flow holes; however, the new cracks were not as long as existing cracks, and CP&L concluded that their size and orientation did not represent an increase in the probability of loose sparger pieces in the vessel. No segments of the spargers had separated from around the flow holes.

Feedwater Nozzles

NUREG-0619 questioned the long-term effectiveness of the interference-fit sparger design because the interference fit may be lost with time. Bypass leakage past the juncture of the thermal sleeve and nozzle safe end may cause crack initiation in the feedwater nozzles due to high cycle thermal fatigue.

In 1991, during refueling outage 9, CP&L examined the Unit 2 blend radius regions on all four feedwater nozzles using both UT and LP techniques. No relevant indications were found (Ref. 2). In Unit 2 refueling outage 10 (spring 1994), UT examinations of the safe ends and blend radii of all four nozzles were conducted. No recordable indications were identified (Ref. 4).

NRC Generic Letter (GL) 81-11 provided amplifying information related to NUREG-0619. That GL included a limiting criterion for crack growth in reactor vessel feedwater nozzles due to combined stresses, i.e. an assumed crack will not grow to more than 1 inch in 40 years. On October 9, 1995, CP&L submitted (Ref. 3) a Unit 2-specific feedwater nozzle fracture mechanics analysis prepared by GE. The analysis did not demonstrate compliance with the criterion described in GL 81-11. The analysis did show, however, that the growth of the same assumed crack (initial depth of 0.25 inches in the nozzle inner blend radius) would be slow, i.e., would reach a depth of 1.0 inch over a 32.3 year period. CP&L therefore concluded that the intent of GL 81-11 has been met in that an assumed 0.25 inch deep crack, not detected during the refueling outage 9 examinations, would not exceed allowable limits during the remaining design life of the unit.

GE noted (Ref. 3) that there were potential conservatisms in its fracture mechanics analysis with regard to the number of nozzle thermal cycles assumed. CP&L stated (Ref. 3) that the GE analysis conservatively assumed that all the nozzle thermal cycles (experienced to date and projected) are full design cycles. A separate analysis performed for CP&L by Structural Integrity Associates (SIA) in April 1993 (Ref. 6) calculated a fatigue usage for the nozzles as of April 21, 1992, of 0.064 with an extrapolated usage of 0.210 for 40 years. CP&L has concluded (Ref. 3) that the SIA results show that the cycles experienced to date have not been as severe as those used in the original feedwater nozzle design and those used in the GE analysis.

GE stated (Ref. 3) that bypass leakage and conservative heat transfer coefficients were assumed in its fracture mechanics analysis. Since the bypass leakage assumption has a significant impact on resulting thermal stresses, GE recommended that some form of leakage assessment or monitoring be performed so that measured leakage flow could then be factored into the analysis. CP&L stated (Ref. 3) that the absence of cracking in the Unit 2 feedwater nozzle blend radii suggests that the interference-fit is tight and that there is presently minimal or no bypass leakage. Based upon the absence of nozzle cracking and the SIA analysis results discussed above, CP&L has concluded (Ref. 3) that implementation of feedwater sparger leakage monitoring is not needed at this time.

During the upcoming operating cycle between Unit 2 refueling outages 11 and 12, CP&L and the BWR Owners Group (BWROG), with the assistance of the Electric Power Research Institute (EPRI) Nondestructive Examination Center, plan (Ref. 3) to qualify an enhanced UT examination technique (using the GE GERIS 2000 system) to inspect the inside surface of the feedwater nozzles from the nozzle outside surface. CP&L will follow the recommendations contained in a BWROG document entitled "Alternate BWR Feedwater Nozzle Inspection Requirements" that will be submitted to the NRC. The examination technique will be capable

of inspecting the area extending from the nozzle inner radius to the safe end. It will be qualified on a full-scale mockup with implanted cracks. CP&L's objective (Ref. 3) is to perform the enhanced UT inspections in lieu of LP examinations during Unit 2 refueling outage 12 (B213R1), scheduled to begin in September 1997.

NRC Staff Conclusion Regarding Feedwater Sparger Replacement

After reviewing the information provided in Reference 1, as supplemented on January 10, 1996, the NRC finds CP&L's plan to not replace the BSEP, Unit 2, feedwater spargers acceptable. NRC approval is conditioned upon CP&L obtaining NRC concurrence prior to changing its current commitment to perform a visual (VT) inspection of the spargers each refueling outage. NRC approval is based upon the sparger NDE results to date, the maximum projected length of existing circumferential weld cracks at the end of the upcoming operating cycle as compared with the maximum allowable, the addition of a new feedwater control system on Unit 2 during refueling outage 10 which reduces the number of feedwater flow fluctuations during low power operations, CP&L'S commitment to perform a VT inspection of the spargers each refueling outage, and the lack of high cycle thermal fatigue cracking in the feedwater nozzle inner blend radii, which would suggest bypass leakage is minimal.

NRC Staff Conclusion Regarding Feedwater Nozzle Examination Deferment

After reviewing the information provided in Reference 3, the NRC finds CP&L's request to defer the LP inspection of the Unit 2 feedwater nozzle blend radii one refueling cycle to be acceptable. The purpose of the deferral is to allow additional time for CP&L to complete qualification of an enhanced UT nozzle examination technique. This approval is based upon: (1) the fact that no blend radii cracks have been identified by either LP or UT testing to date; (2) the low probability, as demonstrated by fracture mechanics analysis, of significant growth of an undetected crack over the deferment period; (3) CP&L's commitment to perform the LP examination of the feedwater nozzle blend radii during Unit 2 refueling outage 12; and (4) the hardship posed by personnel exposure that would be incurred by the performance of the LP examinations.

NRC approval is required before enhanced UT examination is implemented in lieu of nozzle blend radii LP examinations.

CP&L is requested to continue to provide the NRC with a summary of the results of examinations of the feedwater nozzles and spargers and any contingency repairs made based on examination findings.

If you have any questions, please contact me.

Sincerely,

(Original Signed By)

David C. Trimble, Project Manager
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Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-324

cc: See next page

REFERENCES:

1. J.P. Cowan, Carolina Power & Light Company, letter to U.S Nuclear Regulatory Commission, August 17, 1995.

2. D.C. Trimble, U.S. Nuclear Regulatory Commission, letter to R.A. Anderson, Carolina Power & Light Company, March 16, 1995.

3. W.R. Campbell, Carolina Power & Light Company, letter to U.S. Nuclear Regulatory Commission, October 9, 1995.

4. R.P. Lopriore, Carolina Power & Light Company, letter to U.S. Nuclear Regulatory Commission, December 21, 1994.

5. D.C. McCarthy, Carolina Power & Light Company, letter to U.S. Nuclear Regulatory Commission, July 27, 1992.

6. G.D. Hicks, Carolina Power & Light Company, letter to U.S. Nuclear Regulatory Commission, November 14, 1995.

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