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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 73 TO FACILITY OPERATING LICENSE NO. DPR-23

CAROLINA POWER AND LIGHT COMPANY

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

DOCKET NO. 50-261

INTRODUCTION

By letter dated July 13, 1982, as supplemented September 24, 1982, Carolina Power and Light Company submitted the results of the steam generator (S/G) inspection program conducted during the 1982 refueling outage and corrosion rate calculations justifying continued operation for 6 EFPM and requested that the 3 EFPM restriction in License Condition 3.I.a be removed.

The 1982 refueling outage S/G inspection was started in March 1982 and the plant went back into operation in July 1982. The inspection covered 100% of the tubes in all three S/G's. A review of the eddy current data revealed that defective tubes in "B" and "C" S/G's were primarily the result of phosphate thinning above the tubesheet on the cold and hot legs with some intergranular attack in the tubesheet crevice region on the hot legs of both S/G's.

All tubes with eddy current indications greater than 47% (defective tubes) were taken out of service by mechanical plugging. This is consistent with the requirements of Technical Specification 4.2.5.2.

In the July 13, 1982 letter the licensee proposed to operate the 6 EFPM after restart from the refueling outage. At that time an inspection of the S/G's would be performed to ensure that further progression of phosphate thinning does not become excessive.

Prior to cycle 9 start up, the staff requested additional justification and consequently had not completed the review of the licensee's request. Therefore, the staff imposed a licensing condition restricting cycle 9 operation to 3 EFPM until additional information was provided for staff review to justify 6 EFPM of operation. The licensee's letter dated September 24, 1982, provided this information.

DISCUSSION

Plant performance at H. B. Robinson Unit 2 has been closely monitored by NRC for the past three years. The facility has had defects at U-bends, at or above the support plates, inside tubesheet, at top of tubesheet, and above the top of the tubesheet. The degradation above the tubesheet and at or slightly above the support plates is believed to be phosphate induced thinning. Robinson Unit 2 is one of two PWR units which continues to operate with phosphate secondary water chemistry control. The degradation within the tubesheet is believed to be intergranular corrosion phenomenon which has been observed at other units. Two tube specimens containing U-bend indications were removed during the August 1980 outage. Laboratory examination indicates that the U-bend defects were the result of corrosion induced thinning.

The S/G's at H. B. Robinson Unit 2 were inspected in May 1981. One hundred eighty-two (182) tubes were plugged as a result of the May 1981 inspection. The unit returned to operation on June 12, 1981. A primary-to-secondary leak occurred within 48 days from the May 1981 outage. At the time of the shutdown, H. B. Robinson was operated at a power level of approximately 95%. An eddy current inspection was conducted in August 1981.

The August 1981 S/G inspections revealed a total of 212 tubes with eddy current indications in excess of the 47% plugging limit or distorted signals below the tubesheet (crevice region). These tubes were plugged prior to restart.

Since November 18, 1981, plant operating temperature has been lowered to 560°F to reduce stress corrosion cracking activity in the tubesheet region.

The 1982 inspection consisted of all unplugged tubes in each S/G and included the full length of tubing (tube end to tube end), except for nine tubes where U-bend restriction prohibited probing of that area.

The inspections were performed using multi-frequency eddy current equipment. The inspection frequencies utilized were 400 KHz differential, 200 KHz differential, 10 KHz differential and 100 KHz absolute. Various signal frequency mixes were utilized to aid in the detection of tube wall degradation.

The results of the eddy current inspections indicated the presence of degraded and/or defective tubing in four distinct regions of the S/G tube bundles, namely:

1. Top of the Tubesheet/Above the Tubesheet (TTS/ATS) Region

2. Crevice Region

3. Tube Support Region

4. U-bend Region

Review of the inspection results and calculated corrosion rates revealed a continuation of tube wall corrosion in some of the regions where corrosion and tube degradation have occurred in the past. With the exception of the tubesheet crevice region, the ongoing corrosion appears to be a thinning process. The cracking phenomenon previously experienced above the tubesheet appears to have been completely arrested by the current low temperature operation program.

Corrosion appears to have continued with little change from its previously observed rate in the tubesheet crevice region in spite of the low temperature operation. However, for the period from September 1, 1981 to November 6, 1981, the unit was operated with a T_{HOT} of 575°F whereas T_{HOT} was reduced to 560°F for the period of November 17, 1981 until February 25, 1982. Therefore, the observed crevice corrosion could be attributed to the residual effects of previous high temperature operation at 575°F T_{HOT}, and can be expected to decrease during cycle 9 when T_{HOT} will be limited to 560°F.

However, the thinning corrosion rates for some of the TTS/ATS regions are higher than those observed for recent past operating periods. This was believed to be due to the reduced temperature program which resulted in lower secondary temperature and correspondingly higher phosphate concentrations.

No significant corrosion appears to have occurred in either the U-bend or tube support plate region in any of the steam generators.

In order to justify six months full power operation, the licensee projected corrosion rates for the present (9th) cycle of operation based on comparison of eddy current indications of the most recent inspection in April 1982 and the two previous inspections in May 1981 and August 1981.

Two previous inspections were used because not all of the S/G tubes were inspected in August 1981; therefore, some comparisons had to be made with the May 1981 inspection. The overall corrosion rates were conservatively calculated since the corrosion period used for all tubes was assumed to be for the shorter operating period between inspections, i.e., the period from August 1981 to April 1982. This resulted in a corrosion period of 95 Effective Full Power Days (EFPD).

The calculated corrosion rates based on eddy current readings are as follows:

Region	Total	No. Data Points	Rate %/EFPM
"A" S/G Inlet TTS/ATS	-692	192	-1.14
"A" S/G Outlet TTS/ATS	-165	121	- .43
"A" S/G U-bend	- 68	28	- .78
"B" S/G Inlet TTS/ATS	- 50	.85	- .085
"B" S/G Outlet TTS/ATS	593	240	.78
"B" S/G U-bend	- 10	12	- .025
"C" S/G Inlet TTS/ATS	257	113	.72
"C" S/G Outlet TTS/ATS	1025	285	1.14
"C" S/G U-bend	-	0	

The most limiting corrosion rate calculated above was 1.14% per EFPM for the "C" S/G outlet TTS/ATS region and this value was used to conservatively estimate a projected corrosion rate for the present cycle in order to determine the maximum safe operating period for the H. B. Robinson S/G's. Using the 47% technical specification plugging limit and a 42% minimum wall thickness required to maintain tube integrity, an 11% corrosion allowance is available for safe operation.

With a 1.14% EFPM projected corrosion rate and a 11% corrosion allowance, the S/G's can be safely operated for 9.6 EFPM, and therefore, according to the licensee, an inspection performed prior to exceeding 6 EFPM will ensure tube bundle integrity. The projected safe operating period was based on operation at T_{HOT} of 560°F.

The licensee provided date from pulled tubes experiencing wastage to indicate that the eddy current technique overestimates penetration depth when wastage type penetrations are involved. Therefore, the licensee contends that the conservatism inherent in the field eddy current readings of wastage penetrations allows one to discount eddy current error in projecting safe operating period using corrosion allowances calculated from corrosion rates based on eddy current readings.

In addition to the eddy current inspections, an inspection of the secondary side of "B" S/G was performed to identify any foreign objects capable of causing damage to the tube bundle. No such foreign objects were detected, nor was there any evidence of mechanical damage on the exterior of the tubes inspected.

In addition to mechanical plugging of tubes with eddy current indications in excess of the Technical Specification plugging limit, there were several tube weld repairs made, and one special mechanical plug repair. A total of 16 tubes were plugged in "A" S/G, 134 in "B" S/G, and 49 in "C" S/G.

EVALUATION

The H. B. Robinson Unit No. 2 steam generators were subjected to a state-of-the-art eddy current inspection to detect and quantify tube wall corrosion on essentially 100% of the unplugged tubing. This inspection revealed tube degradation in several distinct regions of each steam generator where degradation has been observed in the past. While no new corrosion phenomonon was observed, there was an increase in phosphate wastage attack in some regions.

The licensee's evaluation of eddy current inspection results to determine corrosion rates and to establish a safe operating period to maintain tube integrity under normal and accident conditions indicated that the steam generators can be operated for at least a 9.6 EFPM period at reduced temperature (T_{HOT} = 560°F) and maintain the tube integrity. However, the calculation of corrosion rates did not include tubes which were plugged due to indications > 47% nor did the calculation of corrosion allowance include eddy current uncertainty.

The conservatism cited by the licensee in using 1.14% per EFPM as an upper bound corrosion rate is offset by not including plugged tubes in the corrosion rate calculations. We can accept, however, the contention that eddy current indications overpredict wastage type flaw depth; and hence, eddy current uncertainty need not be included in calculations of corrosion allowances to establish a safe period of operation.

We have noted that the licensee has taken steps to reduce the corrosion rate by sludge lancing, crevice flushing, and lowering plant operation to T_{HOT} of 560°F.

SUMMARY

We have determined that the licensee has not provided an adequate technical basis to support 9.6 EFPM of operation because of uncertainties in the corrosion rate calculations. However, based on the above discussion, the licensee's request for no less than 6 EFPM of operation is acceptable provided that steam generator inspection be conducted after 6 EFPM of operation, and that the reduced limits on primary to secondary leakage rate limits imposed since August 1981 are continued.

ENVIRONMENTAL CONSIDERATION

We have determined that the amendment does not authorize a change in effluent types or total amounts nor an increase in power level and will not result in any significant environmental impact. Having made this determination, we have further concluded that the amendment involves an action which is insignificant from the standpoint of environmental impact and, pursuant to 10 CFR §51.5(d)(4), that an environmental impact statement or negative declaration and environmental impact appraisal need not be prepared in connection with the issuance of this amendment.

CONCLUSION

We have concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously considered and does not involve a significant decrease in a safety margin, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Date: December 10, 1982