

November 3, 2000

Mr. William T. Cottle  
President and Chief Executive Officer  
STP Nuclear Operating Company  
South Texas Project Electric  
Generating Station  
P. O. Box 289  
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNIT 1 - REVIEW OF REFUELING OUTAGE STEAM  
GENERATOR TUBE INSPECTION REPORT (TAC NO. MA7385)

Dear Mr. Cottle:

In a letter dated July 23, 1999, Houston Lighting and Power Company submitted its steam generator tube (SGT) inspection (90-day) report, "South Texas Unit-1 Cycle 9 Voltage-Based Repair Criteria Report." The report was submitted in accordance with the voltage-based alternate repair criteria in the South Texas Project, Unit 1 (STP-1) technical specifications (TSs). The repair criteria was implemented in the TSs in accordance with Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking." The report summarizes the condition for monitoring and the operational assessments for SGTs during cycles 8 and 9, respectively. Your staff inspected STP-1 SGTs in the spring of 1999 at the end of cycle 8. STP-1 is currently operating in cycle 9.

Using the U.S. Nuclear Regulatory Commission's (NRC's) approved methodology, your staff estimated a conditional tube burst probability at the end of cycle 9 to be well below the reporting threshold of  $1 \times 10^{-2}$  for STP-1. In addition, your staff's estimate of the primary-to-secondary tube leak rate during a postulated main steam line break occurring at the end of cycle 9 was below the allowable leak rate of 15.4 gallons per minute.

The NRC staff conclude that you have implemented the voltage-based repair criteria in accordance with its licensing basis and the NRC staff's review of the report is enclosed.

Sincerely,

*/RA/*

Tae Kim, Senior Project Manager, Section 1  
Project Directorate IV & Decommissioning  
Division of Licensing and Project Management  
Office of Nuclear Reactor Regulation

Docket No. 50-498

Enclosure: Safety Evaluation

cc w/encl: See next page

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The NRC staff conclude that you have implemented the voltage-based repair criteria in accordance with its licensing basis and the NRC staff's review of the report is enclosed.

Sincerely,

**/RAI**

Tae Kim, Senior Project Manager, Section 1  
Project Directorate IV & Decommissioning  
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Docket No. 50-498

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\* No substantive changes to SE

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February 2000

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
OF THE STEAM GENERATOR 90-DAY REPORT  
SOUTH TEXAS PROJECT UNIT 1  
DOCKET NO. 50-498

1.0 INTRODUCTION

By letter dated July 23, 1999, Houston Lighting and Power Company submitted for staff review, a steam generator tube (SGT) inspection (90-day) report, "South Texas Unit-1 Cycle 9 Voltage-Based Repair Criteria Report." The report was submitted in accordance with the voltage-based alternate repair criteria in the South Texas Project, Unit 1 (STP-1) technical specifications (TSs). The repair criterion was implemented in the TSs in accordance with Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking." The report summarizes the licensee's condition monitoring and operational assessments of the SGTs for cycles 8 and 9 operations, respectively. The licensee inspected STP-1 SGTs at the end of cycle 8 (EOC-8) in spring 1999. STP-1 is currently operating in cycle 9.

The alternate repair criteria in STP-1 TSs allow SGTs having outside diameter stress corrosion cracking (ODSCC) that is predominately axially oriented and confined within the tube support plates (TSPs) to remain in service on the basis of, in part, bobbin coil voltage response. GL 95-05 guidelines for implementing the voltage-based repair criteria stated that inspection results and associated tube integrity analyses should be submitted within 90 days of each plant restart following an SGT inspection. The report should include, at a minimum, the projected EOC voltage distribution, the postulated tube leakage, and tube burst probability under main steamline break (MSLB) conditions.

2.0 GENERAL PLANT DESCRIPTION

Unit 1 has four Westinghouse Model E2 Steam Generators (SGs) A, B, C, and D. The tubes are ¾-inch in diameter and were fabricated from a mill annealed alloy 600. The SGs have drilled hole carbon steel TSPs.

On May 22, 1996, the staff approved the licensee's implementation of the 1-volt SG voltage-based alternate repair criteria in accordance with GL 95-05 in amendment number 83. The voltage-based tube repair criteria (1) permits tubes having indications confined to within the thickness of the TSPs with bobbin voltages less than or equal to 1 volt to remain in service; (2) permits tubes having indications confined to within the thickness of the TSPs with bobbin voltages greater than 1 volt but less than or equal to the upper voltage repair limit to remain in service if a motorized rotating pancake coil (RPC) probe or an acceptable inspection alternative

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does not detect degradation; and (3) requires tubes having indications confined within the thickness of the TSPs with bobbin voltages greater than the upper voltage limit be plugged or repaired. The licensee calculated the upper voltage limit for the TSPs to be 4.0 volts.

### 3.0 STAFF ASSESSMENT

#### 3.1 Inspection Scope and Results

At EOC-8, the licensee inspected all tubes full length in all four SGs. The licensee used 0.610-inch diameter bobbin probes to inspect all hot and cold leg TSP intersections where the voltage-based repair criteria were applied. In addition, the licensee used RPC to reinsert mixed residual indications, non-quantifiable bobbin indications, and those bobbin indications found at TSP intersections.

Using the bobbin probe, the licensee detected a total of 1552 ODSCC indications at TSP intersections during the EOC-8 inspection. Of 1552 indications, 61 indications were over 1 volt which were all found in the hot leg side. All cold leg indications had bobbin voltages less than 1 volt. The licensee used RPC to re-inspect 74 bobbin indications (which included 61 bobbin indications above 1 volt and 13 cold leg indications less than 1 volt) and confirmed 43 flaws. Steam Generator C had the largest number of indications among the four SGs with 614 bobbin indications. The licensee did not find any inside diameter indications at the dented TSP intersections, circumferential indications at the TSP intersections, nor indications extending outside the TSPs.

#### 3.2 Evaluation of Probabilistic Calculations

The licensee performed tube integrity calculations in accordance with GL 95-05 that show the conditional probability of tube burst and tube leak rate under an MSLB are well below the TS reporting threshold. A conditional monitoring assessment was performed for the past cycle, cycle 8. An operational assessment was performed for the current cycle 9. The licensee's calculations are summarized as follows:

##### 3.2.1 Projected End-of-Cycle Voltage Distribution

Before calculating tube burst probability and potential leak rates, the licensee obtained the voltage distributions (number of indications vs. bobbin voltages). The licensee projected the voltage distribution at EOC-8 based on voltage distributions at beginning of cycle 8. The voltage distribution projections were based on a constant probability of detection of 0.6 in accordance with GL 95-05. The projected EOC-8 voltage distributions were compared with the actual EOC-8 voltage distributions as a benchmark against the prediction calculations. The staff noted that above 0.5 volt, the licensee predicted more indications than the actual indications found in the field and, therefore, the projected EOC-8 voltage distribution is conservative. In the range of 0.2 to 0.4 volt, the licensee predicted fewer number of indications than the actual; however, the difference between the predicted and actual number of indications is not significant enough to be of concern.

For the operational assessment, the licensee projected EOC-9 voltage distributions using the voltage distributions at the beginning of cycle 9. The licensee used a growth rate in accordance

with GL 95-05 which recommends that the more conservative growth distribution from the last two cycles be used to project EOC voltage distributions. The licensee used cycle 8 growth rate distributions which bound the cycle 7 growth rate. The staff confirmed that the licensee's calculations on voltage distribution are consistent with GL 95-05.

### 3.2.2 Conditional Probability of Tube Burst During an MSLB

For the condition monitoring assessment, the licensee projected the tube burst probabilities at EOC-8 to be  $9.4 \times 10^{-5}$ ,  $3.1 \times 10^{-5}$ ,  $8.3 \times 10^{-5}$ , and  $4.7 \times 10^{-5}$ , for SGs A, B, C, and D, respectively, using the estimated EOC-8 voltage distribution. The licensee then compared the projected tube burst probabilities with the as-found conditional burst probabilities which were determined to be  $2.1 \times 10^{-4}$ ,  $1.2 \times 10^{-5}$ ,  $4.3 \times 10^{-4}$ , and  $4.2 \times 10^{-5}$  for SGs A, B, C, and D, respectively, using the actual EOC-8 voltage distributions. While there are differences between the projected and the actual tube burst probabilities, the staff notes that the probability values are well below the reporting threshold of  $1 \times 10^{-2}$ .

For the operational assessment, the licensee projected the EOC-9 conditional tube burst probabilities to be  $1.9 \times 10^{-4}$ ,  $2.5 \times 10^{-5}$ ,  $4.2 \times 10^{-4}$ , and  $6.3 \times 10^{-5}$  for SGs A, B, C, and D, respectively. The licensee's projected values are well below the reporting threshold of  $10^{-2}$ , and therefore, the estimated tube burst probabilities due to ODS/CC at TSPs are within acceptable limits for cycle 9 operation.

### 3.2.3 MSLB Leak Rate Projection

For the condition monitoring assessment, using the estimated EOC-8 voltage distribution, the licensee projected EOC-8 leak rate to be  $3.2 \times 10^{-3}$ ,  $8.1 \times 10^{-4}$ ,  $5.3 \times 10^{-3}$  and  $2.0 \times 10^{-3}$  gallons per minute (gpm) for SGs A, B, C, and D, respectively. Using the actual EOC-8 voltage distribution, the licensee calculated the potential leak rates to be  $1.8 \times 10^{-2}$ ,  $3.5 \times 10^{-4}$ ,  $3.8 \times 10^{-3}$  and  $9.6 \times 10^{-4}$  gpm for SGs A, B, C, and D, respectively. The differences in leak rates between those calculated by projected EOC-8 voltage distributions and as-found voltage distributions were caused by the differences in respective voltage distributions. The differences in leak rates are insignificant when compared to the reporting threshold limit of 15.4 gpm.

For the operational assessment, the licensee projected the EOC-9 MSLB leak rates to be  $1.5 \times 10^{-2}$ ,  $1.4 \times 10^{-3}$ ,  $3.4 \times 10^{-2}$  and  $3.2 \times 10^{-3}$  gpm for SGs A, B, C, and D, respectively. All the MSLB leak rates are well below the STP-1 reporting threshold limit of 15.4 gpm and are acceptable. All leak rates were calculated based on the staff-approved equivalent volumetric rate at room temperature.

## 3.3 Database for Tube Integrity Calculations

In order to calculate the conditional tube burst probabilities and postulated primary-to-secondary leak rate, GL 95-05 recommends the use of burst and leak rate data obtained from model boiler tubes and tubes removed from actual SGs. The industry has developed correlations relating bobbin coil voltage to the measured leak rate, probability of leakage, and burst pressure through testing of these tubes. On June 5, 1998, the Nuclear Energy Institute

(NEI) submitted for staff review and approval the SG Degradation Specific Management database, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits." The staff approved the database and associated correlations for 3/4-inch diameter tubes in a letter to NEI dated November 20, 1998, which the licensee used in its tube burst probability and leak rate calculations.

### 3.4 Tube Pull Results

GL 95-05 recommends periodic removal of degraded tube specimens to monitor the morphology of ODS-CC degradation at TSP intersections and to obtain additional data for inclusion in the correlations relating bobbin coil voltage amplitude to tube burst pressure, probability of leakage, and leak rate. The licensee removed four tubes in 1993 and three tubes in 1995, encompassing 18 TSP intersections. Based on the GL 95-05 tube removal schedule, the licensee should remove tube specimens at EOC-8 in 1999. However, by letter dated August 18, 1998, the licensee requested to change its commitment to GL 95-05 to not remove tube specimens at EOC-8 because all steam generators will be replaced at EOC-9. The staff determined that the licensee's request of not removing tube specimens at EOC-8 is acceptable in view of steam generator replacement at EOC-9.

### 3.5 Probe Wear Criteria

The licensee used an alternative method to evaluate probe wear as opposed to the method outlined in GL 95-05 for evaluating probe wear. The method was submitted by NEI and was found acceptable by the NRC staff as discussed in a letter from Brian Sheron of the NRC to Alex Marion of the NEI dated February 9, 1996.

The alternative method specifies that when a probe does not pass the 15-percent wear limit, the licensee is directed to reinspect the full length of all tubes with indications above 75 percent of the voltage limit inspected since the last successful probe wear check. Since the repair limit is 1 volt, all tubes measured with a worn probe containing indications above 0.75 volt were reinspected with a new probe. The licensee followed the above alternative and compared the voltages measured with worn probes to the voltages measured with new acceptable probes to ensure that the voltages measured with the worn probes are comparable. No new indications were detected with the new probes; therefore, it can be stated that the worn probes did not miss significant indications. The licensee's approach for addressing probe wear is acceptable.

## 4.0 SUMMARY

The staff has reviewed the licensee's condition monitoring assessment for cycle 8 and operational assessment for cycle 9 in the STP-1 90-day report. The staff finds that the licensee's assessments are performed in accordance with GL 95-05. Using an NRC-approved methodology, the licensee estimated a conditional tube burst probability at the end of cycle 9 to be well below the reporting threshold of  $1 \times 10^{-2}$  for STP-1. In addition, the licensee's estimate of the primary-to-secondary tube leak rate during a postulated MSLB occurring at the end of cycle 9 was well below the allowable leak rate of 15.4 gpm. The staff concludes that the licensee implemented the voltage-based repair criteria in accordance with its licensing basis.

Principal Contributor: J. Tsao

Date: November 3, 2000