

November 5, 2002

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 (STP), UNIT 2, SUMMARY STAFF EVALUATIONS  
OF 90-DAY STEAM GENERATOR TUBE INSPECTION REPORTS FOR  
REFUELING OUTAGES 7 AND 8 (TAC NOS. MA8116 AND MB2449)

Dear Mr. Cottle:

By letter dated January 25, 2000, and June 28, 2001, STP Nuclear Operating Company (the licensee) submitted its 90 day steam generator (SG) tube inspection reports summarizing the results of inspections during refueling outage 2RE07 and 2RE08, respectively. The June 28, 2001, report was supplemented by letters dated December 5, 2001, and January 9, 2002.

The NRC staff has reviewed your submittals, and prepared the enclosed summary evaluation reports for 2RE07 (Enclosure 1) and 2RE08 (Enclosure 2). Based on the summary evaluation for refueling outage 2RE07, the Nuclear Regulatory Commission (NRC) staff determined that it would not be able to conclude if the tube burst probability and leak rates projected during postulated steam line break accidents at the end of Cycle 8 (EOC-8) would be conservative until the EOC-8 inspections were completed. For that reason the NRC staff decided to provide you combined summary evaluations for both EOC-7 and EOC-8, making conclusive determinations regarding consequences of postulated steam line break accidents.

Based on its evaluations, the NRC staff concludes that the licensee used the NRC-approved methodology to determine the probability of tube burst and primary to secondary SG tube leakage. The calculations indicated that both the tube burst probability and calculated primary to secondary leakage were within the NRC staff's acceptance criteria. Therefore, the NRC staff

W. Cottle

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concludes that the licensee implemented the voltage-based tube repair criteria in accordance with the approved methodology and the inspection results meet the staff's acceptance criteria.

If you have any questions, please contact me at (301) 415-1476.

Sincerely,

*/RA/*

Mohan C. Thadani, Sr. Project Manager, Section 1  
Project Directorate IV  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket No. 50-499

Enclosures: 1. Summary Evaluation Report for 2RE07  
2. Summary Evaluation Report for 2RE08

cc w/encls: See next page

South Texas, Units 1 & 2

cc:

Mr. Cornelius F. O'Keefe  
Senior Resident Inspector  
U.S. Nuclear Regulatory Commission  
P.O. Box 910  
Bay City, TX 77414

A. Ramirez / C. M. Canady  
City of Austin  
Electric Utility Department  
721 Barton Springs Road  
Austin, TX 78704

Mr. M. T. Hardt  
Mr. W. C. Gunst  
City Public Service Board  
P.O. Box 1771  
San Antonio, TX 78296

Mr. C. A. Johnson / R. P. Powers  
AEP - Central Power and Light Company  
P.O. Box 289, Mail Code: N5022  
Wadsworth, TX 77483

INPO  
Records Center  
700 Galleria Parkway  
Atlanta, GA 30339-3064

Regional Administrator, Region IV  
U.S. Nuclear Regulatory Commission  
611 Ryan Plaza Drive, Suite 400  
Arlington, TX 76011

D. G. Tees / R. L. Balcom  
Texas Genco, LP  
P.O. Box 1700  
Houston, TX 77251

Judge, Matagorda County  
Matagorda County Courthouse  
1700 Seventh Street  
Bay City, TX 77414

A. H. Gutterman, Esq.  
Morgan, Lewis & Bockius  
1111 Pennsylvania Avenue, NW  
Washington, DC 20004

Mr. T. J. Jordan, Vice President  
Engineering & Technical Services  
STP Nuclear Operating Company  
P.O. Box 289  
Wadsworth, TX 77483

S. M. Head, Manager, Licensing  
Nuclear Quality & Licensing Department  
STP Nuclear Operating Company  
P.O. Box 289, Mail Code: N5014  
Wadsworth, TX 77483

Environmental and Natural Resources  
Policy Director  
P.O. Box 12428  
Austin, TX 78711-3189

Jon C. Wood  
Matthews & Branscomb  
112 East Pecan, Suite 1100  
San Antonio, TX 78205

Arthur C. Tate, Director  
Division of Compliance & Inspection  
Bureau of Radiation Control  
Texas Department of Health  
1100 West 49th Street  
Austin, TX 78756

Brian Almon  
Public Utility Commission  
William B. Travis Building  
P.O. Box 13326  
1701 North Congress Avenue  
Austin, TX 78701-3326

September 2002

Susan M. Jablonski  
Office of Permitting, Remediation  
and Registration  
Texas Commission on  
Environmental Quality  
MC-122  
P.O. Box 13087  
Austin, TX 78711-3087

G. R. Bynog, Program Manager/  
Chief Inspector  
Texas Department of Licensing  
and Regulation  
Boiler Division  
P.O. Box 12157, Capitol Station  
Austin, TX 78711

Mr. Ted Enos  
4200 South Hulen  
Suite 630  
Ft. Worth, Texas 76109

concludes that the licensee implemented the voltage-based tube repair criteria in accordance with the approved methodology and the inspection results meet the staff's acceptance criteria.

If you have any questions, please contact me at (301) 415-1476.

Sincerely,

*/RA/*

Mohan C. Thadani, Senior Project Manager, Section 1  
Project Directorate IV  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket No. 50-499

- Enclosures: 1. Summary Evaluation Report for 2RE07
- 2. Summary Evaluation Report for 2RE08

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SUMMARY OF EVALUATION  
OF SOUTH TEXAS PROJECT, UNIT 2 STEAM GENERATOR TUBE  
VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT FOR END OF CYCLE 7

By letter dated January 25, 2000, South Texas Project Nuclear Operating Company (the licensee) submitted its steam generator (SG) tube inspection (90-day) report, "South Texas Unit-2 Cycle 8 Voltage-Based Repair Criteria Report." The report was submitted in accordance with voltage-based alternate repair criteria in the South Texas Project, Units 1 and 2 technical specifications. The Nuclear Regulatory Commission (NRC) staff approved the licensee's repair criteria 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 90-day report contains the licensee's condition monitoring and operational assessments for SG tubes for the cycle 7 operation. The NRC staff reviewed the following areas in the report: inspection results, predicted and actual voltage distribution, conditional probability of tube burst, leak rates, degradation growth rate distributions, probe wear, and consistency of the inspection results with the applicability of the GL 95-05 methodology.

The NRC staff found that using the GL 95-05 methodology, the licensee underpredicted the number and severity of tube indications, tube burst probabilities, and leak rates for the cycle 7 operation because of unexpectedly high degradation growth during cycle 7 (i.e., the voltage growth during cycle 7 exceeded predictions using the GL 95-05 methodology). The licensee recognized the underprediction for the end of cycle 7 (EOC-7) and, for the EOC-8 projection, used a higher degradation growth rate distribution than it had used for the EOC-7 projection. The staff is not clear at this time if the higher burst probabilities and leak rates projected for EOC-8 would be conservative until the assessments using the actual EOC-8 inspection results are made available.

On the basis of its review, the NRC staff concludes that the licensee implemented the voltage-based repair criteria in accordance with the approved methodology. For EOC-8, the licensee projected a conditional tube burst probability to be below the reporting threshold of  $1 \times 10^{-2}$ . The primary-to-secondary tube leak rate during a postulated main steam line break were projected to be below the allowable leak rate of 15.4 gpm. It is anticipated that the licensee will submit the EOC-8 assessments in July 2001, from which the staff intends to assess for consistency with voltage-based methodology.

Principal Contributor: J. Tsao

Date:

Enclosure 1

## SUMMARY OF EVALUATION

### OF SOUTH TEXAS PROJECT, UNIT 2 STEAM GENERATOR TUBE

#### VOLTAGE-BASED REPAIR CRITERIA 90-DAY REPORT FOR END OF CYCLE 8

By letter dated June 28, 2001, the licensee for South Texas Project, Unit 2 (STP 2) submitted its steam generator (SG) 90-day report which summarizes the implementation of the SG tube voltage-based repair criteria during refueling outage 2RE08 (i.e., RFO 8). This report was supplemented by letters dated December 5, 2001 and January 9, 2002.

#### 1.0 BACKGROUND

The licensee has implemented the voltage-based tube repair criteria at STP 2, as discussed in Nuclear Regulatory Commission (NRC) Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995, for several cycles. The repair criteria allow the STP 2 to remain in service with tubes with indications of degradation, provided certain criteria are met. Prior to the end-of-Cycle (EOC) 8 inspection, performed in March 2001, a 1-volt tube repair criterion was implemented at STP 2. During the EOC 8 inspection, a 3-volt repair criterion was approved by the NRC as discussed in an amendment issued on March 8, 2001 (Amendment No. 114, "Revise Technical Specifications to Implement 3-Volt Alternate Repair Criteria for Steam Generator Tube Repair").

Although the licensee was permitted to implement a 3-volt repair criterion for Cycle 9 (scheduled from spring 2001 to fall 2002), the licensee elected to preventively plug all indications over 1.5 volts to minimize the potential for leakage during normal operation. In addition, the licensee plugged a majority of the indications at the tube support plates between 0.6 and 1.5 volts as part of a preventive plugging program. [STP 2 attributed operating leakage observed during Cycle 8 (1999 to 2001) to indications at the tube support plates. Prior to the STP 2 experience, no other plants in the U.S. had attributed normal operating leakage to indications to which the GL 95-05 repair criteria were implemented. The major difference between STP 2 and all other domestic plants implementing the GL 95-05 repair criteria is that the STP 2 SGs have stainless steel tube support plates with drilled holes, whereas all others have carbon steel tube supports with drilled holes.]

The EOC 8 inspection represents the last scheduled inspection for implementation of the voltage-based tube repair criteria at South Texas Unit 2 since the licensee plans to replace the SGs at the refueling outage (i.e., EOC 9), currently in progress.

#### 2.0 TECHNICAL EVALUATION

Implementation of the voltage-based repair criteria requires determination of the probability of tube burst and the postulated primary-to-secondary leakage following a steam line break event (GL 95-05). To perform this analysis, the expected number of locations with degradation and the severity of the degradation at these locations at the end of the next operating cycle is needed. In projecting the EOC conditions, the indications known to be left in service at the

beginning-of-cycle (BOC) are adjusted to account for missed indications (due to equipment and personnel limitations) and the development of new indications. These adjustments are made through the use of a probability of detection (POD) factor of 0.6. This adjustment determines the number of indications expected at the end of the next operating interval. To determine the anticipated severity of these indications (i.e., voltage for GL 95-05 indications) at the end of the next operating interval, these indications are adjusted for potential growth during the next operating cycle and for an uncertainty in the measurement due to wearing of the probe and due to analyst variability. The resultant distribution of indications is then used in determining the probability that a tube will burst and the amount of leakage likely under postulated accident conditions. If the distribution of indications (number and/or severity) at the EOC is under-predicted, the resultant probability of burst and/or postulated leakage may be underpredicted.

Historically, the methodology for predicting the EOC voltage distribution has been conservative in predicting the number of indications (i.e., through the use of a 0.6 POD) and has reasonably predicted the severity of indications (through the use of historic growth rates and models for measurement uncertainty). In the case of STP 2 where the postulated leakage during a steam line break event is approaching the licensee's analyzed limit for such leakage, it is important to evaluate the "conservatism" in the prediction of EOC voltage distributions, particularly the larger voltage indications which tend to contribute the most to burst probability and leakage estimates.

Based on the NRC staff's review of the material provided in References 1 through 3, several instances where the EOC voltage distribution was underpredicted both in terms of the number and severity of indications were identified. The following tables illustrate the results.

**Table 1: Comparison of Number of Indications Predicted versus Observed for Cycles 6, 7, and 8**

Steam Generator	Cycle 6 (1997-1998)		Cycle 7 (1998-1999)		Cycle 8 (1999-2001)	
	Projected	Actual	Projected	Actual	Projected	Actual
A	322	188	293	330	509	611
B	565	500	836	815	1294	1229
C	437	456	749	602	927	972
D	437	340	558	515	792	767
Total	1,761	1,484	2,436	2,262	3,522	3,579

Source: Table 7-4 of Ref. 3, Table 6-4 of Ref. 2, and Table 6-3 of Ref. 1.

As can be seen from Table 1, the number of indications exceeded projections in one SG in Cycle 6, one SG in Cycle 7, and in two SGs in Cycle 8. The projections for the number of indications in the other SGs were comparable to what was observed for the last 2 cycles.

With respect to the severity of the indications detected, the methodology tended to under predict the number of larger voltage indications. Table 2 provides the number of indications detected that were greater than 1 volt for Cycles 6 through 8 and compares it to the projected results. Table 3 provides similar information for indications greater than 2 volts. As can be seen from Table 3, the larger voltage indications tended to be under predicted.



**Table 2: Comparison of Severity of Indications Predicted versus Observed for Cycles 6, 7, and 8 (greater than 1 volt indications)**

Steam Generator	Cycle 6 (1997-1998)		Cycle 7 (1998-1999)		Cycle 8 (1999-2001)	
	Projected > 1 V	Actual > 1 V	Projected > 1 V	Actual > 1 V	Projected > 1 V	Actual > 1 V
A	94	18	35	33	127	106
B	28	3	26	37	244	108
C	55	10	37	48	227	117
D	12	8	44	42	158	117
Total	189	39	142	160	756	448

Source: Table 7-4 of Ref. 3, Table 6-4 of Ref. 2, and Table 6-3 of Ref. 1

**Table 3: Comparison of Severity of Indications Predicted versus Observed for Cycles 6, 7, and 8 (greater than 2 volt indications)**

Steam Generator	Cycle 6 (1997-1998)		Cycle 7 (1998-1999)		Cycle 8 (1999-2001)	
	Projected > 2 V	Actual > 2 V	Projected > 2 V	Actual > 2 V	Projected > 2 V	Actual > 2 V
A	2	4	6	7	18	43
B	1	0	1	8	34	33
C	0	1	2	11	32	41
D	0	1	3	8	24	46
Total	3	6	12	34	108	163

Source: Table 7-4 of Ref. 3, Table 6-4 of Ref. 2, and Table 6-3 of Ref. 1.

The underprediction of the severity of the degradation could be attributed to higher than expected growth rates and/or a lower probability of detection at South Texas Unit 2 with a bobbin coil. With respect to the growth rates, Table 4 illustrates the average growth rate has been increasing since Cycle 6. With respect to the probability of detection, the NRC staff notes that the confirmation rate of bobbin indications with a rotating probe appears to be very high (nearly 100 percent) at STP 2. This confirmation rate appears to be higher than that observed at other plants implementing the criteria.

**Table 4: Average Growth Rates for Cycles 5, 6, 7, and 8**

Cycle	Period	Duration (EFPD)	Number of Indications	Average Growth Rate per EFPY <sup>1</sup>	Average BOC Voltage
5	1995-1997	450	703	31%	0.31
6 (2RE06)	1997-1998	564.9	1484	27%	0.31
7 (2RE07)	1998-1999	342.5	2262	45%	0.41
8 (2RE08)	1999-2001	458	3580	82%	0.37
9	2001-2002	485 (planned)			

<sup>1</sup>Average percentage increase in beginning-of-cycle voltage  
 Source: Table 3-5 and page 6-2 of Ref. 1, and Ref. 4 (page 12 of 17).

Table 5 presents the indications left inservice at BOC 8 and 9 as a function of voltage indicating that a similar distribution of indications was left inservice for these two cycles.

**Table 5: Indications Left Inservice as a Function of Voltage**

Voltage	BOC 8 (1999)	BOC 9 (2001)
0.1	0	1
0.2	35	45
0.3	215	292
0.4	450	552
0.5	435	539
0.6	353	475
0.7	224	246
0.8	146	150
0.9	95	80
1.0	61	39
1.1	0	19
1.2	1	11
1.3	0	2
1.4	0	4
1.5	0	1
<b>TOTALS</b>	2,015	2,456

Source: Table 3-1 of Ref. 2 and Table 3-1 of Ref. 1

To summarize the results from the prior inspections, (1) the number of indications was under-predicted for 1 of the 4 SGs at EOC 7 and for 2 of the 4 SGs at EOC 8, (2) the number of indications above 2 volts was underpredicted in all 4 SGs at EOC 7, and the number of indications above 3 volts was underpredicted in all 4 SG at EOC 8, (3) the average percentage increase in beginning of cycle voltage (i.e., composite growth rate) increased from Cycle 6 (27 percent) to Cycle 7 (45.4 percent) to Cycle 8 (81.9 percent), and (4) more BOC indications were left in service this cycle than last (although the number of indications above 0.9 volts is comparable to prior cycle).

Since the above results appear to question the use of a 0.6 POD and/or the use of historic growth rates to predict EOC conditions at STP 2, the NRC requested additional information from the licensee. The licensee addressed this issue by its letters dated December 5, 2001, and January 9, 2002. In its responses, the licensee provided justification supporting its approach. Although the licensee did not provide quantitative analysis confirming that the actions they outlined in its letters would have resulted in conservative projections (had they been performed in prior cycles), the licensee did provide credible qualitative arguments to support the adequacy of its EOC projections and the resultant primary-to-secondary leak rate.

Using the EOC projections discussed above, the licensee used an NRC approved methodology to determine the probability of burst and the primary-to-secondary leakage during a postulated steam line break. These calculations indicated that both the probability of burst and the primary-to-secondary leakage during a postulated steam line break were within the NRC's acceptance criteria.

### 3.0 CONCLUSIONS

Based on the above and the NRC staff's review of the licensee's submittals, the NRC staff concludes that the licensee implemented the voltage-based repair criteria in accordance with the approved methodology.

### 4.0 REFERENCES

1. June 28, 2001, letter from Mark E. Kanavos, South Texas Project Nuclear Operating Company, "2REO8 Steam Generator Tube Voltage-Based Repair Criteria 90-day Report."
2. January, 25, 2000, letter from S.E. Thomas, South Texas Project Nuclear Operating Company, "Unit 2 Seventh Refueling Outage Steam Generator Tube Voltage Based Repair Criteria 90 day Report."
3. January 19, 1999, letter from S.E. Thomas, South Texas Project Nuclear Operating Company, "2REO6 Steam Generator Tube Voltage-Based Repair Criteria 90-day Report."
4. May 10, 2001, letter from Mark Kanavos, South Texas Project Nuclear Operating Company, "Licensee Event Report 2-01-003, Steam Generator 2C Classified as Category C-3."

5. June 27, 2001, letter from M.E. Kanavos, South Texas Project Nuclear Operating Company, "Special Report - 2RE08 Refueling Outage Inservice Inspection Results for Steam Generator Tubing."

Principal Contributor: K. Karwoski

Date: November 5, 2002