Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

December 5, 2001
NOC-AE-01001222

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

South Texas Project
Unit 2
Docket No. STN 50-499
Response to Request for Additional Information Regarding the
2RE08 Steam Generator Tube Voltage-Based Repair Criteria 90-Day Report

Reference: Letter, M. E. Kanavos to NRC, "2RE08 Steam Generator Tube Voltage-Based Repair Criteria 90-Day Report," dated June 28, 2001 (NOC-AE-01001108)

The response to an NRC request for additional information regarding the referenced report is attached to this letter. If there are any questions regarding this response, please contact Mr. Chet McIntyre at (361) 972-8597 or me at (361) 972-7181.

Mark E. Kanavos
Manager, Replacement Steam Generator
Project Engineering

jtc

Attachment

A001

STI: 31383740

cc:

Ellis W. Merschoff
Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

Mohan C. Thadani
Addressee Only
U. S. Nuclear Regulatory Commission
Project Manager, Mail Stop OWFN/7-D-1
Washington, DC 20555-0001

Cornelius F. O'Keefe
U. S. Nuclear Regulatory Commission
P. O. Box 289, Mail Code: MN116
Wadsworth, TX 77483

A. H. Gutterman, Esquire
Morgan, Lewis & Bockius
1800 M. Street, N.W.
Washington, DC 20036-5869

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

Jon C. Wood
Matthews & Branscomb
112 East Pecan, Suite 1100
San Antonio, Texas 78205-3692

Institute of Nuclear Power
Operations - Records Center
700 Galleria Parkway
Atlanta, GA 30339-5957

Richard A. Ratliff
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756-3189

D. G. Tees/R. L. Balcom
Reliant Energy, Inc.
P. O. Box 1700
Houston, TX 77251

C. A. Johnson/A. C. Bakken III
AEP - Central Power and Light Company
P. O. Box 289, Mail Code: N5012
Wadsworth, TX 77483

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

ATTACHMENT

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

1. Accuracy of EOC voltage predictions

To summarize the above [information provided by the Staff], (1) the number of indications was under predicted for 1 of the 4 steam generators at EOC 7 and for 2 of the 4 steam generators at EOC 8, (2) the number of indications above 2 volts was under predicted in all 4 steam generators at EOC 7, and the number of indications above 3 volts was under predicted in all 4 SG at EOC 8, (3) the composite growth rate increased from Cycle 6 (27%) to Cycle 7 (45.4%) to Cycle 8 (81.9%), 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).

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. As a result, please provide the basis for assuming the methodology used to predict the expected EOC 9 voltage distribution (and the resultant primary-to-secondary leakage and probability of burst estimates) will be conservative for Cycle 9.

Response:

This response summarizes the methods applied for the end of cycle (EOC) 9 projections that were more conservative than the standard alternate repair criteria (ARC) methodology. Preventive actions to reduce the potential for leakage and increased conservatism in the analysis methods were both implemented for Cycle 9. These formed the basis for assuming that the methodology used to predict the EOC 9 voltage distribution would be conservative. The actions taken for these two activities are described below.

Preventive Actions

The following preventive actions were taken during the 2RE08 outage to reduce the potential for leakage during Cycle 9:

- All bobbin indications above 1.5 volts at TSP intersections were repaired.
- Selective preventive plugging of Distorted Support Indications (DSIs) down to 0.6 volts was implemented during 2RE08 based on maximum indicated rotating pancake coil (RPC) depth and length (criteria described in attachment 2 of Reference 1). Based upon +Point sizing of the confirmed bobbin indications, DSIs predicted to leak by EOC 9 at approximately an upper 95% confidence limit were preventively repaired.

These actions significantly reduced the potential for leakage during Cycle 9 operation.

Conservatism in ARC EOC 9 Leakage Analyses

The following steps were included in the EOC 9 operational assessment to increase the conservatism in the projections beyond that required by Generic Letter (GL) 95-05:

- The limiting growth distribution from steam generator (SG) D was used in the projections for all SGs.
- The largest five growth values from other SGs were added to the SG D growth distribution to provide an upper bound on the large growth tail of the distribution for Cycle 9 analyses. Sensitivity analyses performed for the Cycle 8 ARC 90-day report Table 7-3 (Reference 2) show that the addition of three largest growth values to the SG specific growth increases the steam line break (SLB) leak rate by 17%. The addition of the five largest growth rates to the limiting SG growth distribution further increases conservatism in the leak rate analyses.
- A conservative SLB leak rate of 5 gpm was assigned to indications restrained from burst (IRBs) in the Monte Carlo analyses for the operational assessment.
- A leak rate analysis was performed that applied a factor of 1.3 across the voltage distribution range of the conservatively developed growth described above. STP reviewed the industry operating history to identify the largest DSI growth experience either in the U.S. or in Europe where larger indications are left in service. This experience included DSIs up to 4½ volts left in service. The maximum growth was 11 volts/EFPY compared to the 8.6 volt/EFPY maximum growth experienced at STP during Cycle 8. The factor of 1.3 (11/8.6) applied to the growth distribution bounds the international experience on voltage growth. The results of this analysis showed that the administratively imposed reduced reactor coolant iodine limits which result in a 34 gpm SLB leakage limit would continue to be met.

The above efforts provide for conservatism in the SLB leak rate projections well beyond the GL 95-05 and 3-volt ARC requirements. This approach ensures that EOC 9 leak predictions are conservative.

The increasing voltage growth rates were recognized in the Cycle 8 report (Reference 2) and sensitivity analyses were performed to assess this trend. These analyses (Table 7-3 of the report) showed acceptable leak rates although not anticipating the larger step increase in growth found for Cycle 8. It should be noted that increases in voltage growth rates do not imply corresponding increases in depth growth rates. In the April 19, 2001 meeting with the NRC, it was shown that bobbin voltage increases exponentially with respect to incremental increases in depth for indications approaching or at the through-wall condition. This exponential effect of voltage on depth leads to increasing voltage growth trends that are not reflected in the use of prior cycle growth distributions for the operational assessments.

Section 3.4 in Reference 1 evaluated the STP experience with probability of detection (POD). The STP results are comparable to the industry experience and show the conservatism in applying POD = 0.6. POD is not an issue at STP for the TSP indications. The high RPC confirmation rate at STP does not imply a potentially lower POD, but rather is a result of reduced signal distortion due to lack of corrosion at the stainless steel TSPs. Underestimates of the total number of indications at TSP intersections is not meaningful for the operational assessments because the largest number of indications are low voltage indications that have negligible influence on leak rates or burst probabilities. The larger than projected EOC 8 indications are due to the larger voltage growth rates than used in the operational assessment, which is addressed by the actions described above.

2. Secondary Side Pressure Test Implications

As discussed in Reference 3, operational primary-to-secondary leakage was identified during Cycle 8, and a 600 psi secondary side pressure test was conducted during the subsequent refueling outage to identify possible leaking tubes. The leakage rate under the test conditions was no greater than 1 drop per minute and many tubes did not drip at all rather they were just wet. In Reference 2, 54 tubes with indications above 4 volts were identified as leakers during this pressure test. In addition, in Reference 4, it was indicated that approximately 40 tubes were preventively plugged due to being suspected leaking tubes (presumably these were below the repair limits). During the April 19 meeting, a table listing all of the tubes identified as leakers during the secondary side pressure test was provided along with the voltages for tube support plate indications. Several of these tubes leaked even though the indications in the tube were of relatively small voltages (and the differential pressure during the pressure test was less than would be experienced during a steam line break). Are the results of the secondary side pressure test consistent with the generic probability of leakage model? For the tubes that leaked during the pressure test, please provide a list of any other eddy current indications detected in these tubes (e.g., wear, free span indication, etc.) and address the possibility that these indications were contributing to the leakage.

Response:

The goal of the secondary side pressure test was to supplement the NDE detection of potential leaking tubes such that the restart of STP Unit 2 would be free from tube leakage. The secondary side pressure tests at STP 2RE08 were conducted at a sustained 600 psi pressure over a four-day period. This allowed the identification of very small amounts of weepage once the temporary channel head ventilation was secured. For some locations, the very low levels of wetting on the tubes could have led to overestimates of the number of leaking tubes. The eddy current results for these leaking tubes were provided to the NRC at the April 19 meeting and are attached to the NRC meeting notes (Reference 5). A tabulation of the possibly leaking tubes, including associated support plate eddy current data, is provided as Table 2-1 in this report. A list of other eddy current signals detected in the possibly leaking tubes is provided in Table 2-2. The voltage information presented in Table 2-1 represents the final data used for the ODSCC ARC analysis after performing the re-size evaluation for obtaining growth rates, whereas the voltages given in the list provided at the April meeting were taken from field eddy current data. Several errors in the identification of DSI locations (02H, 03H, etc.) were discovered in the list provided at the April meeting and these have been corrected in Table 2-1.

An analysis was performed using the available data that demonstrates that the results of the secondary side pressure test are consistent with the generic probability of leakage model. The following information provides the details of the development of the database used for this evaluation:

- The Reference 2 ARC report lists 611, 1229, 972, and 768 indications for SGs A, B, C and D, respectively. The database used for the ODCSS ARC analyses was used for this evaluation. This means that the final voltage amplitudes for the indications may have changed from those provided in the April meeting as a result of evaluations performed to develop the final database.
- A total of 104 tubes were reported leaking during the secondary side pressure test. Of these, no degradation was detected in 15 tubes (8 in SG A, 0 in SG B, 6 in SG C, and 1 in SG D). All of the tubes and indications and their associated voltages where leaking was implied by the secondary side pressure test are listed in Table 2-1. The remaining 89 tubes have a total of 128 indications. Seven of the tubes had three indications and twenty-five tubes had two indications. A probability of leakage (POL) of 1 was assigned to the largest indication if multiple indications were in the same tube and the remaining indications were removed from the database.
- A total of 12 tubes were leak tested in situ (1 in SG A, 3 in SG B, 2 in SG C, and 6 in SG D). Two of the tubes in SG B that were reported as leaking during the secondary side pressure test were tested in situ. The tube with an indication of 9.72 volts leaked at normal operation differential pressure conditions and the tube with an indication of 6.93 volts did not (it did leak at 2000 psi). Four of the tubes in SG D that were reported as leaking during the secondary side pressure test were tested. The tube with a bobbin amplitude of 11.09 volts leaked at 1440 psi, while indications with amplitudes of 7.90, 7.45, and 10.37 volts did not leak at the simulated normal operation differential pressure. However, they had leakage at 2000 - 2500 psi. For purposes of this analysis, these indications were assumed to have been leaking during normal operation and assigned a POL of 1 for the analysis regardless of the results of the in situ test.

A very conservative POL evaluation was performed assuming that all tubes implied to be leaking were indeed tubes that would leak during operation, i.e., "squeeze leakers". The remaining indications found during the inspection are considered to be non-leakers. A POL regression analysis was performed using this database and the analysis results were compared to the result using the EPRI generic database of test results. Figure 2-1 illustrates the data and the results of the analysis. The specified squeeze leakers are shown with a POL of 1. The remaining indications used in the ARC analysis are shown as "+" symbols with a POL of 0. The solid line on the figure illustrates the EPRI database solution and the solution using the STP ODSCC data is shown using a dashed line. The results from this analysis support the use of the POL curve obtained from the generic database. The two curves are in quite good agreement up to bobbin amplitudes of 2 volts. The ARC data beyond that indicate that a POL lower than that of the EPRI generic curve might be expected. A second analysis was initially considered that would assume that only the tubes actually observed to drip during the secondary side pressure test were leakers. However, given the result from the first analysis, the need for the second analysis is obviated, i.e., the match to the generic curve would only be expected to improve or confirm that the generic curve is conservative.

There is also the potential that further comparisons could lead to results that would be seemingly contradictory. This is because there were large indications that did not leak. Prior experience considering non-domestic testing results demonstrated that the inclusion of large indications that do not leak leads to a prediction curve with a higher POL at lower voltages. This is because the prediction equation is symmetric in log-log plots. If the right tail of the curve is elongated by large voltage data with a POL of zero, the left tail will also be elongated, resulting in higher POL values, counter to the physical expectations.

Table 2-1: Bobbin and +Point Results for Flaw-Like Indications in Tubes Identified as Potentially Leaking During the Secondary Side Pressure Test

Indication	Bobbin Code	Bobbin Volts	+Point[1] Code	Indication	Bobbin Code	Bobbin Volts	+Point[1] Code
A-R04C050	None			C-R07C104-02H	DSI	3.85	SAI
A-R04C061	None			C-R11C108-02H	DSI	4.44	MAI
A-R07C081	None			C-R12C107-02H	DSI	0.46	
A-R08C067	None			C-R13C018-02H	DSI	0.70	SAI
A-R08C081	None			C-R16C073-02H	DSI	1.93	
A-R13C049	None			C-R17C069-02H	DSI	5.61	MAI
A-R20C033	None			C-R17C069-03H	DSI	3.82	MAI
A-R22C043	None			C-R17C070-02H	DSI	6.13	MAI
C-R01C043	None			C-R17C070-03H	DSI	0.32	
C-R05C045	None			C-R18C081-02H	DSI	4.09	MAI
C-R05C080	None			C-R20C073-02H	DSI	8.07	SAI
C-R24C051	None			C-R20C098-04H	DSI	5.27	SAI
C-R25C049	None			C-R20C098-02H	DSI	0.51	MAI
C-R25C050	None			C-R20C098-03H	DSI	0.27	
D-R04C031	None			C-R21C035-03H	DSI	4.53	SAI
A-R09C022-02H	DSI	2.26		C-R21C088-02H	DSI	6.12	SAI
A-R11C092-02H	DSI	5.83	SAI	C-R21C088-04H	DSI	1.88	
A-R13C027-02H	DSI	5.97	SAI	C-R22C088-03H	DSI	6.08	SAI
A-R13C027-03H	DSI	0.47		C-R22C091-03H	DSI	0.47	MAI
A-R13C032-02H	DSI	1.33	SAI	C-R22C092-04H	DSI	7.36	MAI
A-R14C030-02H	DSI	2.93		C-R22C092-05H	DSI	0.80	MAI
A-R14C030-04H	DSI	0.23		C-R22C092-03H	DSI	0.27	
A-R14C050-02H	DSI	1.02	SAI	C-R23C023-03H	DSI	0.86	SAI
A-R15C030-03H	DSI	1.38	SAI	C-R23C023-02H	DSI	0.16	SAI
A-R15C030-02H	DSI	1.03	SAI	C-R23C091-02H	DSI	4.20	SAI
A-R17C048-02H	DSI	2.52		C-R24C024-02H	DSI	4.06	SAI
A-R18C034-02H	DSI	4.35	MAI	C-R24C071-03H	DSI	3.28	SAI
A-R18C045-02H	DSI	3.13	SAI	C-R24C071-05H	DSI	0.61	
A-R19C029-02H	DSI	6.35	SAI	C-R34C081-02H	DSI	3.44	SAI
A-R19C054-02H	DSI	5.45	MAI	C-R43C074-02H	DSI	4.07	SAI
A-R19C054-03H	DSI	0.61	SAI	C-R43C074-03H	DSI	0.69	SAI
A-R20C032-03H	DSI	2.57		D-R08C024-03H	DSI	0.72	
A-R20C034-02H	DSI	4.48	SAI	D-R08C024-02H	DSI	0.48	
A-R20C080-02H	DSI	7.32	MAI	D-R10C109-02H	DSI	10.37	SAI
A-R21C088-02H	DSI	4.46	SAI	D-R17C108-02H	DSI	3.23	SAI
A-R22C030-02H	DSI	6.95	SAI	D-R19C077-03H	DSI	6.67	SAI
A-R22C076-02H	DSI	3.00		D-R20C028-02H	DSI	4.30	SAI
A-R22C078-02H	DSI	7.05	MAI	D-R20C028-04H	DSI	0.31	SAI
A-R22C079-03H	DSI	2.27		D-R20C028-03H	DSI	0.30	

Table 2-1: Bobbin and +Point Results for Flaw-Like Indications in Tubes Identified as Potentially Leaking During the Secondary Side Pressure Test

Indication	Bobbin Code	Bobbin Volts	+Point[1] Code	Indication	Bobbin Code	Bobbin Volts	+Point[1] Code
A-R22C088-03H	DSI	2.73		D-R21C027-02H	DSI	5.08	SAI
A-R23C024-02H	DSI	8.05	SAI	D-R21C027-03H	DSI	4.04	SAI
A-R23C038-02H	DSI	4.03	MAI	D-R22C033-03H	DSI	4.02	SAI
A-R23C038-03H	DSI	0.81	SAI	D-R22C033-02H	DSI	0.58	
A-R24C082-03H	DSI	5.37	MAI	D-R22C036-02H	DSI	4.80	SAI
A-R25C038-02H	DSI	1.80		D-R22C036-03H	DSI	0.36	
A-R25C038-03H	DSI	0.37		D-R22C042-03H	DSI	2.56	
A-R25C066-02H	DSI	4.55	SAI	D-R22C042-02H	DSI	0.25	
A-R26C083-02H	DSI	2.09		D-R22C101-03H	DSI	2.06	
A-R26C083-03H	DSI	0.77	MAI	D-R23C042-02H	DSI	6.82	SAI
A-R29C028-02H	DSI	4.46	MAI	D-R23C064-02H	DSI	2.10	
B-R10C030-02H	DSI	3.53	SAI	D-R23C064-04H	DSI	0.42	
B-R11C100-02H	DSI	4.85	MAI	D-R23C078-03H	DSI	3.40	SAI
B-R12C011-02H	DSI	3.14	SAI	D-R23C078-02H	DSI	0.41	
B-R12C016-02H	DSI	5.44	SAI	D-R24C046-03H	DSI	7.06	SAI
B-R12C092-03H	DSI	3.28	SAI	D-R24C047-03H	DSI	11.06	SAI
B-R12C092-02H	DSI	0.64	SAI	D-R24C047-02H	DSI	5.44	SAI
B-R15C089-02H	DSI	9.72	SAI	D-R24C047-05H	DSI	0.66	
B-R17C031-02H	DSI	6.45	SAI	D-R24C068-04H	DSI	7.85	SAI
B-R17C038-02H	DSI	3.20	MAI	D-R24C068-03H	DSI	0.49	
B-R17C039-03H	DSI	5.95	MAI	D-R24C068-05H	DSI	0.35	
B-R17C039-02H	DSI	3.43	SAI	D-R25C047-02H	DSI	7.21	SAI
B-R20C048-03H	DSI	6.93	MAI	D-R25C047-03H	DSI	6.15	SAI
B-R20C048-02H	DSI	1.11	SAI	D-R25C047-05H	DSI	0.34	
B-R21C045-02H	DSI	1.87		D-R25C069-02H	DSI	3.59	SAI
B-R21C082-02H	DSI	2.82		D-R25C072-02H	DSI	7.45	SAI
B-R25C048-03H	DSI	2.75		D-R25C072-04H	DSI	1.20	SAI
B-R25C066-02H	DSI	5.69	MAI	D-R26C026-02H	DSI	4.33	SAI
B-R28C071-03H	DSI	6.67	SAI	D-R27C020-02H	DSI	4.73	SAI
B-R32C036-04H	DSI	2.33		D-R27C028-04H	DSI	5.25	MAI
B-R32C036-02H	DSI	2.03		D-R30C028-02H	DSI	3.49	MAI
B-R32C036-03H	DSI	0.80	SAI	D-R30C028-04H	DSI	0.73	MAI
B-R40C042-03H	DSI	3.89	MAI				

Notes:
1. Blank entries indicate that the location was not tested.

Table 2–2: Non-Flaw Indications in Tubes Identified as Potentially Leaking During Secondary Side Pressure Test			
SG-Tube	MRI	MBM	DNG
A-R08C067			1.15V @ 23C+5.08
C-R05C080			1.74V @ 12C+18.15
C-R25C049		0.89V @ 08H+27.59 1.33V @ 09H+39.97 1.14V @ 12C+25.14 1.67V @ 14C+25.54	
D-R04C031			1.00V @ 08H+1.25
A-R09C022	2.26V @ 02H		
A-R11C092	5.78V @ 02H		
A-R13C027			1.30V @ TSH+4.25 0.79V @ 01H+0.94 1.29V @ 01H+7.03 1.17V @ 01H+13.10
A-R14C050	1.02V @ 02H		
A-R15C030	1.20V @ 02H		
A-R19C054	5.46V @ 02H		0.91V @ TSH+2.83
A-R20C032			0.99V @ 07H+29.95
A-R20C034	1.15V @ 20C		1.05V @ 12C+43.50
A-R20C080	5.64V @ 02H		
A-R21C088	4.43V @ 02H	1.16V @ 05H+38.96	
A-R22C030	1.00V @ 03H		
A-R22C076	2.87V @ 02H		
A-R22C078	6.77V @ 02H		
A-R22C079	2.60V @ 03H		
A-R22C088	2.45V @ 03H		1.33V @ 14C+38.70
A-R23C024	7.92V @ 02H		
A-R23C038	4.01V @ 02H	1.62V @ 12C+25.22 2.21V @ 13C+23.12	0.91V @ 22C+6.80
A-R24C082	5.16V @ 03H 1.06V @ 05H		
A-R25C066	4.74V @ 02H		1.27V @ AV1+6.77
A-R26C083	2.20V @ 02H		
A-R29C028			5.43V @ 19C+10.99
B-R10C030	3.55V @ 02H		
B-R11C100	4.84V @ 02H		
B-R12C011	3.13V @ 02H		
B-R12C092	3.24V @ 03H	(9) 0.63V to 2.24V, 06H+36.92 to 15C+8.99	

Table 2–2: Non-Flaw Indications in Tubes Identified as Potentially Leaking During Secondary Side Pressure Test			
SG-Tube	MRI	MBM	DNG
B-R15C089	8.70V @ 02H		
B-R17C031	6.44V @ 02H		
B-R17C038	3.19V @ 02H		
B-R17C039	3.32V @ 02H 5.73V @ 03H		1.08V @ 04H+21.27 0.94V @ 04H+22.65 0.77V @ 04H+24.03
B-R20C048	6.93V @ 03H 1.11V @ 02H	2.29V @ 06H+21.2 2.77V @07H+11.86 1.55V @ 08H+19.35	
B-R21C045	1.80V @ 02H		
B-R21C082	2.91V @ 02H		(17) 1.33V to 2.59V, TSH+2.55 to 03H+26.13
B-R25C048	2.75V @ 03H		1.69V @ AV2+10.32
B-R25C066	5.52V @ 02H		1.25V @ 20C+2.09
B-R28C071	6.67V @ 03H		3.96V @ 09H+5.21
B-R32C036	2.17V @ 02H 1.55V @ 03H 2.30V @ 04H		
B-R40C042	3.88V @ 03H		
C-R07C104	3.86V @ 02H		
C-R12C107		1.52V @ 05H+6.36	1.20V @ 22C+10.32
C-R13C018			1.49V @ 02H+10.09
C-R16C073		1.60V @ 03H+5.80	
C-R17C069	5.51V @ 02H 3.76V @ 03H		
C-R17C070	6.13V @ 02H		
C-R18C081		(9) 0.66V to2.30V; 05H+22.74 to 08H+8.26	1.50V @ 10H+17.29 1.76V @ AV3+9.15
C-R20C073	8.16V @ 02H	0.58V @ 15C+17.05 0.86V @ 21C+5.55	
C-R20C098	5.10V @ 04H		
C-R21C035	4.52V @ 03H	3.04V @ 03H+27.16	
C-R21C088	1.89V @ 04H		
C-R22C088		0.75V @ 04H+18.37	
C-R22C091	1.08V @ 02H 1.05V @ 05H		
C-R22C092	7.14V @ 04H 1.07V @ 05H		

Table 2–2: Non-Flaw Indications in Tubes Identified as Potentially Leaking During Secondary Side Pressure Test

SG-Tube	MRI	MBM	DNG
C-R23C091	4.19V @ 02H		
C-R24C024	4.07V @ 02H 1.46V @ 03H	0.87V @ 13C+6.53	
C-R24C071	3.21V @ 03H		
C-R34C081	3.43V @ 02H		
C-R43C074	4.06V @ 02H 1.32V @ 03H		
D-R08C024		1.82V @ 07H+20.46	1.19V @ 08H+15.87
D-R10C109	10.55V @ 02H		
D-R17C108	3.20V @ 02H		
D-R19C077	7.02V @ 03H		0.78V @ 06H+39.58 2.91V @ 08H+7.66 2.21V @ 16C+4.19 2.76V @ 08H+8.40
D-R20C028	4.31V @ 02H		
D-R21C027		2.07V @ 06H+32.33	
D-R22C033	4.04V @ 03H	1.29V @ 06H+22.72	
D-R22C101	2.04V @ 03H		
D-R23C064	2.13V @ 02H		
D-R23C078	3.40V @ 03H		
D-R24C046		1.95V @ 07H+26.52 2.16V @ 16C+36.68	
D-R24C047	5.38V @ 02H 10.95V @ 03H		
D-R24C068	7.96V @ 04H		
D-R25C047	7.14V @ 02H 6.08V @ 03H		
D-R25C069	3.48V @ 02H		
D-R25C072	7.27V @ 02H 1.17V @ 04H		
D-R26C026	4.35V @ 02H		
D-R27C020	4.71V @ 02H		
D-R27C028	5.26V @ 04H		
D-R30C028	3.50V @ 02H		

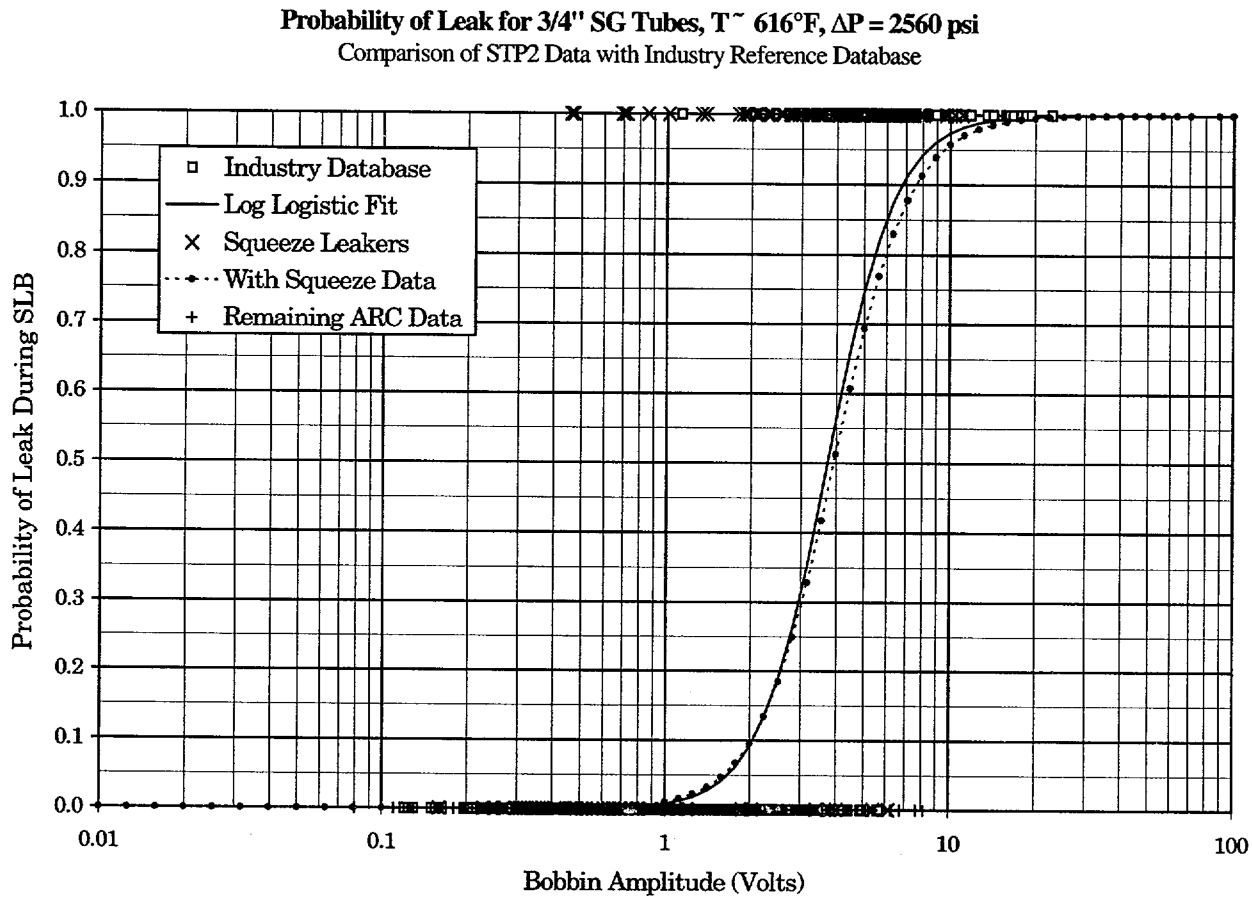

Figure 2-1: Comparison of POL Curves Using ODSCC Data

3. Correlation between in-situ leakage test results and actual operating leakage

During 2RE08, six indications at the tube support plate elevations were in-situ leak and pressure tested as discussed in Reference 3. All of these indications leaked during the secondary side pressure test discussed above. With this information, the information provided in Attachment 2 to Reference 2, the information discussed during conference calls and at the April 19, 2001, public meeting, the staff attempted to correlate the total leakage observed from a steam generator during actual plant operation to the leakage actually measured during the in-situ pressure tests discussed above. Based on the information provided the staff could not reconcile the amount of leakage observed during plant operation to the amount of leakage reported during the in-situ pressure tests as discussed below.

The total leakage from steam generator B during normal operation was 7.5 gallons per day (gpd) at the end of cycle 8. One of the more "severe" indications was pressure tested and the "best estimate normal operating leak rate" was determined by the licensee to be 0.03 gpd. Assuming this was just an average indication (which is probably a non-conservative assumption), it would take approximately 250 such indications in steam generator B to account for the 7.5 gallons per day total steam generator leakage (assuming the 7.5 gpd and 0.03 gpd are reported for the same temperature conditions).

As a result of the above, the staff requests the licensee assess how the leakage measured during the in-situ pressure tests corresponds to the leakage measured during actual plant operation. The assessment should address the conditions under which the in-situ measurements were made (i.e., all pressures and temperatures) and the subsequent adjustments to the data to account for differences in temperature and pressure. All data should be provided including data collected under normal operating and steam line break conditions. The assessment should also assess the possibility that the leakage was coming from other types of degradation and/or very low voltage indications. Please consider the information from this assessment in responding to question 1 above.

For each in-situ pressure data point, provide the pressure (primary and secondary) and temperature at the flaw location and the pressure, temperature, and volumetric leak rate measured in the "collection chamber." For each of these data points, provide the equations and the resultant calculation for correcting the leak rate data to the "appropriate condition" (i.e., the temperatures and pressures for normal operation and for steam line break conditions). If multiple equations are used (to correct for material properties, fluid density, differential pressure, and flashing), provide the intermediate results. Provide the temperature and pressure (primary and secondary) assumed for normal operating and steam line break conditions at the flaw location.

Response:

STP agrees that no practical correlation can be established between the operational leakage experienced during cycle 8 operation and that measured in situ for DSIs at tube-to-tube support plate (TSP) intersections. A practical correlation should not be expected, as there are too many unknowns for a meaningful comparison of operating leakage with in situ measurements for indications at TSP intersections. The unknowns preventing a comparison include:

- The degree of deposit compaction in the support plate crevice and the amount of impurities deposited within the crack are variable between operating and shutdown conditions. During operation, the measured leak rates tended to decrease, which was likely due to increased corrosion product deposition within the cracks. Performance of the 2RE08 secondary side pressure test, which held pressure on the crack OD probably resulted in a change in deposition location, the extent of deposition within the crack, and possibly the distribution of deposits within the crevice. Crevice and crack deposition conditions during the in situ testing of indications within support plate crevices could not duplicate conditions that existed during operation. The secondary side pressure test could have led to plugging of indications with deposits that affected leak rates at normal operating pressure differentials, but the deposits may have been blown out of the crack at the higher SLB pressure differentials due to increased crack opening at higher pressures. Based on these types of non-quantifiable crevice and crack effects, the EPRI In Situ Pressure Guidelines do not recommend leak testing of ODSCC at support plates.
- The likelihood of deposits plugging the cracks at the normal operation differential pressure, ΔP_{NO}, is supported by the in situ test results in that all six indications at TSP intersections that were in situ tested leaked at the SLB differential pressure, ΔP_{SLB}, but only two indications leaked at ΔP_{NO}. The potential for leakage at the ΔP_{SLB} condition without leakage at ΔP_{NO} is small as indicated by the ODSCC ARC database. Out of 92 ARC database indications with reported leakage at ΔP_{SLB}, 89 of the indications also had leakage at ΔP_{NO}. Only 2 of the 92 leaking indications had reported corrosion crack depths that were not through-wall so that the potential for ligament tearing to through-wall is also low for ODSCC indications at TSP intersections. Consequently, it is very likely that the four indications that did not leak at ΔP_{NO} in the in situ tests were influenced by deposits in the crack from the secondary side pressure tests. Deposits may also have reduced the normal operating leak rate for the two indications with reported in situ leakage.
- A tube not tested may have had a higher normal operating leak rate than the indications tested. The in situ tests included 2 of 8 indications in SG B and 4 of 13 indications in SG D that were > 4.4 volts and found to leak in the pressure tests. Nominal analyses at operating conditions using +Point profiles predicted 3 leakers in SG B and 8 leakers in SG D, with total leak rates exceeding the measured leak rates during Cycle 8 operation.

STP leak tested the larger voltage DSIs in two SGs to demonstrate that axial tearing strength had not been exceeded which was deduced from leak rates much below the 5 gpm "restrained from burst" leak rate. In addition, the tests were performed to demonstrate that the operating leakage was attributable to the large voltage indications at TSP intersections. There was no intent for the in situ tests to provide quantifiable leak rates because such quantification was not considered to be feasible.

The results of the in situ leak tests, including the test conditions and the leak rates adjusted to normal operating and SLB pressure differentials, have been separately provided to the NRC and are not included with this response. This is in response to the last paragraph of the request for additional information. It should be noted that in situ tests are generally performed at ambient conditions and are conducted without water on the secondary side of the SG, hence the downstream pressure is 14.7 psi. The volumetric leak rate as a function of bobbin amplitude data presented in ODSCC ARC reports is based on the density of the fluid at ambient conditions.

As to the possibility that leakage was coming from other types of degradation and/or very low voltage indications, the nature of other degradation in the potentially leaking tubes is not such that the leakage is considered feasible, nor would any industry experience suggest that leakage would be from very low voltage indications. The STP Unit 2 tube pull examinations that included field-called DSIs down to 0.24 volts supports this.

References

1. Letter, S. E. Thomas to NRC, "Unit 2 Seventh Refueling Outage Steam Generator Tube Voltage Based Repair Criteria 90 Day Report," January 25, 2000 (NOC-AE-00000297, NOC-AE-00000757)
2. Letter, M. E. Kanavos to NRC, "2RE08 Steam Generator Tube Voltage-Based Repair Criteria 90-day Report," June 28, 2001 (NOC-AE-01001108)
3. Letter, M. E. Kanavos to NRC "Licensee Event Report 2-01-003, Steam Generator 2C Classified as Category C-3," May 10, 2001 (NOC-AE-01001096)
4. Letter M. E. Kanavos to NRC, "Special Report - 2RE08 Refueling Outage Inservice Inspection Results for Steam Generator Tubing," June 27, 2001 (NOC-AE-01001124)
5. Letter, M. C. Thadani, "Summary of Meeting with STPNOC/Westinghouse Regarding Results of Steam Generator Tube Inspections and In Situ Tube Pressure Tests Conducted During End-of-Cycle 8 Refueling Outage for South Texas Project Unit 2," May 15, 2001 (AE-NOC-0100812)