

VIRGINIA ELECTRIC AND POWER COMPANY  
RICHMOND, VIRGINIA 23261

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United States Nuclear Regulatory Commission  
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Gentlemen:

**VIRGINIA ELECTRIC AND POWER COMPANY**  
**SURRY POWER STATION UNITS 1 AND 2**  
**ANNUAL STEAM GENERATOR INSERVICE INSPECTION SUMMARY REPORT**

Pursuant to Technical Specification 4.19.F.b for Surry Power Station Units 1 and 2, Virginia Electric and Power Company is submitting the results of the steam generator tube inservice inspections performed during 1999. The results of the steam generator tube inspections conducted on Unit 2 during the Spring 1999 refueling outage are included in the attachment. There were no inspections performed on Unit 1 steam generators in 1999.

This letter does not establish any new commitments. Should you have any questions or require additional information, please contact us.

Very truly yours,



David A. Christian  
Vice President - Nuclear Operations

Attachment

cc: U. S. Nuclear Regulatory Commission  
Region II  
Atlanta Federal Center  
61 Forsyth Street, SW, Suite 23 T85  
Atlanta, GA 30303-3415

Mr. R. A. Musser  
NRC Senior Resident Inspector  
Surry Power Station

A047

**Virginia Power  
Surry Unit 2 1999  
Annual Steam Generator Report**

Station	Unit	Outage Date	Generator Examined			Date of Report
Surry	2	May, 1999	A			12/28/99

Scope of Inspection					
SG	Inspection Program	Planned	Inspected	Inspection Method	Extent
A	Cold Leg	3335 *	3334	Bobbin	TEH - TEC
A	Hot Leg	281	281	Bobbin	TEC - TEH
A	U-Bend	187	187	Bobbin	7H - 6C
A	Row 1 U-Bend RPC	19	19	3-Coil RPC	7H - 7C
A	TTSH RPC	670	670	3-Coil RPC	TSH +/- 3"
A	Special Interest Cold Leg	75	75	3-Coil RPC	N/A
A	Special Interest Hot Leg	54	54	3-Coil RPC	N/A

\*Note: Restricted tube was plugged.

Indications of Imperfections Detected							
SG	NDE Method	Row	Column	Indication Code	Location	Active Yes/No	Measured Wall Penetration
A	Bobbin	25	57	16%	AV2	No	16%
A	Bobbin	26	9	14%	AV4	No	14%
A	Bobbin	26	86	24%	AV3	No	24%
A	Bobbin	29	70	13%	AV2	No	13%
A	Bobbin	31	13	12%	AV4	No	12%
A	Bobbin	36	62	21%	AV2	No	21%
A	Bobbin	36	62	19%	AV4	No	19%
A	Bobbin	38	72	26%	AV4	No	26%
A	Bobbin	40	49	13%	AV1	No	13%
A	Bobbin	40	49	12%	AV3	No	12%
A	Bobbin	40	65	23%	AV2	No	23%
A	Bobbin	7	36	PIT	TSC + 4.7	No	15%
A	Bobbin	6	38	PIT	TSC + 3.8	No	31%
A	Bobbin	4	45	PIT	TSC + 2.3	No	27%
A	Bobbin	9	51	PIT	TSC + 3.2	No	10%
A	Bobbin	4	43	PIT	TSC + 2.4	No	20%
A	Bobbin	7	49	PIT	TSC + 4.3	No	24%
A	Bobbin	7	57	PIT	TSC + 3.1	No	10%

<b>Tube Plugging</b>		
<b>SG</b>	<b>Reason/Mechanism</b>	<b>Tubes Plugged</b>
A	Pits	7
A	Restricted Tube	1
C *	Pit	1
<b>Total Tubes Plugged</b>		<b>9</b>

**Note\*** It was decided to plug all reported pit indications due to NDE sizing uncertainty. Therefore, tube R25 C13 was plugged in "C" SG due to 26% through wall pit indication reported in 1995.

<b>Repair Attributions</b>				
<b>SG</b>	<b>Row</b>	<b>Column</b>	<b>Reason/Mechanism</b>	<b>Repair Method</b>
A	4	43	Pit	Plug
A	4	45	Pit	Plug
A	6	38	Pit	Plug
A	7	36	Pit	Plug
A	7	49	Pit	Plug
A	7	57	Pit	Plug
A	9	51	Pit	Plug
A	1	36	Restricted Tube	Plug
C	25	13	Pit	Plug

<b>Plugging/Repair Record</b>					
<b>SG</b>	<b>Tubes Plugged</b>	<b>Tubes Repaired (Not Plugged)</b>	<b>Percent Plugged</b>	<b>Percent Repaired (Not Plugged)</b>	<b>Percent Plugged or Repaired</b>
A	15	N/A	0.45%	N/A	0.45%
B	7	N/A	0.21%	N/A	0.21%
C	10	N/A	0.30%	N/A	0.30%

## TUBE INTEGRITY ASSESSMENT

### Anti-Vibration Bar (AVB) Wear

The last operating interval between inspections of the "A" steam generator was 44.2 effective full power month (EFPM). The next operating interval is projected to be approximately 48.2 EFPM.

The following table summarizes the projected through wall (TW) depths for the identified AVB wear locations at the end of the next planned operating interval for the "A" steam generator. These projections are based on the largest growth rate (3.7%/cycle) observed during the last operating interval plus a total NDE uncertainty of 14.6%. Included in the Table 4 below is the %TW projection based on using the standard deviation technique versus the 95/95 deviation technique.

**Table 1 AVB Projections**

Row / Column	AVB Location	% TW 1999 Outage (A)	Projected % TW (At The End Of The Next Planned Operating Interval – 48.2 EFPMs)	
			B (95/95)	C (Std. Dev.)
R25 C57	AV2	16	42.7	37.0
R26 C9	AV4	14	40.7	35.0
R26 C86	AV3	24	50.7	45.0
R29 C70	AV2	13	39.7	34.0
R31 C13	AV4	12	38.7	33.0
R36 C62	AV2	21	47.7	42.0
	AV4	19	45.7	40.0
R38 C72	AV4	26	52.7	47.0
R40 C49	AV1	13	39.7	34.0
	AV3	12	38.7	33.0
R40 C65	AV2	23	49.7	44.0

Note: %TW (2003) = %TW (1999) + [(Maximum Past Growth Rate Observed x # of Operating Cycles Until Next Inspection) x Next Operating Interval in EFPM / Last Operating Interval in EFPM] + Total NDE Uncertainty

$$B = A + [(3.7 \times 3) \times 48.2 / 44.2] + 14.6$$

$$C = A + [(3.7 \times 3) \times 48.2 / 44.2] + 8.91$$

Taking the maximum past operating interval growth ( 3.7 % / cycle x 3 cycles = 11.1 % ) for the 44.2 EFPMs of operation and adjusting it based on the scheduled 48.2 EFPMs of operation until the next inspection of the "A" steam generator, results in a projected total growth of 12.1 % for the next operating interval. Adding this growth to the largest AVB indication measured during the current outage, i.e., 26%, gives a projected through wall wear depth of 38.1 % at the end of the next operating interval. By adding the most conservative total NDE uncertainty (14.6%) to the calculated wear depth of 38.1%, the worse case wear depth projected at the end of Cycle #14 is 52.7% through wall or

0.0237 inch remaining wall. Since this projected wear depth leaves remaining wall greater than the bounding structural limit of 0.020 inch, no tubes were plugged for this condition.

### **Pit Indications**

The pitting seen in the Surry Unit 2 steam generators is believed to have initiated prior to chemical cleaning. No detectable growth has been observed since their initial detection based on the "A" steam generator inspection results. With the removal of the major contributor to pitting, copper rich sludge, along with the improved chemistry control program, initiation of new pits is unlikely during the next operating interval for the "A" steam generator. Tubes with known pit indications have been removed from service in Unit 2 "A" and "C" steam generators. Three of the remaining four steam generators at Surry Units 1 & 2 have been inspected with the current pit screening criteria in place in the Analysis Guidelines with no pit indications observed. The one remaining steam generator, Unit 1 "C", is scheduled to be inspected in April of 2000. The Surry Unit 1 steam generators were similarly chemically cleaned in December 1994, and similar chemistry control improvements have been instituted thus reducing the potential for active degradation of this type. Based on past history, any undetected pits below the detection threshold for bobbin are not expected to grow to a depth exceeding structural or leakage margin requirements before the end of the next planned inspection interval.

Based on laboratory testing of machined specimens under burst pressure loadings, failure of a pit type indication would be expected to penetrate the tube wall (i.e., "pop-through"), without tearing of the non-pitted material. The opening of the material at the bottom of the pit would not be classified as a burst which, by definition, requires tearing that would extend the size of the flaw. Consequently, opening of the bottom of the pit is a leakage concern rather than a burst concern. Based on industry experience for burst testing of thinned and machined flat samples and adjusting the burst pressure values by 1.1 for the geometry of a pit, actual depths of about 93% would be required to result in opening of the material at the bottom of the pit at 3 delta P conditions. A depth of 95% would be required to result in leakage at steam line break conditions. As is shown in Table 2 and 3, the %TW depths (adjusted for the most conservative total NDE uncertainty of 38.1%) for the pit indications in the "A" and "C" steam generators are well below these values.

The other eddy current parameter, which supports the structural integrity of the Surry Unit 2 steam generators during the past operating period, is the bobbin voltage. Based on industry experience, in order for pitting degradation to represent a burst potential, the pits must be clustered together in a tight group with significant depths or be large (i.e., >0.125 inch) in diameter at significant depths. Such conditions would be expected to exhibit bobbin voltages well in excess of the voltage recorded for the 100% TW hole of the ASME standard (0.067 inch diameter). Westinghouse has utilized a conservative value of 85% of the 100% TW ASME voltage value as a threshold value for considering insitu pressure testing. Using the Channel 1 Mix, the bobbin voltage measured for the 20% TW hole ASME standard was 2.85 volts, and the 100% TW ASME hole was 6.21 volts. As shown in Tables 2 and 3 below, the bobbin voltages measured for the indication reported in the "A" and "C" steam generators are well below this threshold

value.

Based on the above factors, no structural or leakage integrity concerns have been identified for the planned operating interval of the Surry Unit 2 steam generators. Each margin relative to these performance criteria has been met.

**Table 2 Summary of Pit Indications – “A” Steam Generator – Spring 1999**

Row / Column	Insp. Date	Location	% TW (Bobbin) 400/100 Mix	% TW + 22.6 % (Total NDE Uncertainty Based On Standard Deviation)	% TW + 38.1% (Total NDE Uncertainty Based On 95/95 Probability Distribution)	% TW (UT Sizing Based On ASME Flat Bottom Hole Standard)
R7 C36	1979 1995 1999	NDD TSC + 4.5" TSC + 4.7"	NDD 22(1.71V) 15(1.75V)	N/a 44.6 37.6	N/a 60.1 53.1	N/a N/a 43 Max
R6 C38	1979 1988 1991 1995 1999	NDD TSC + 4.2" TSC + 4.2" TSC + 3.4" TSC + 4.2" TSC + 3.8" TSC + 4.2" TSC + 3.8"	NDD 27 INF 33 30(1.33V) 27(1.37V) 24(1.45V) 31(1.36V)	N/a 49.6 N/a 55.6 52.6 49.6 46.6 53.6	N/a 65.1 N/a 71.1 68.1 65.1 62.1 69.1	N/a N/a N/a N/a N/a N/a 55 Max ----
R4 C45	1979 1983 1991 1995 1999	NDD NDD NDD TSC + 3.1" TSC + 2.1" TSC + 3.2" TSC + 2.3"	NDD NDD NDD 10 (0.54V) 29 (0.42V) 14 (0.49V) 27 (0.47V)	N/a N/a N/a 32.6 51.6 36.6 49.6	N/a N/a N/a 48.1 67.6 52.1 65.1	N/a N/a N/a N/a N/a 43 Max ----
R9 C51	1995 1999	TSC + 3.19" TSC + 3.19"	15(0.29V) 10(0.29V)	37.6 32.6	53.1 48.1	N/a 18 Max
R4 C43	1995 1999	TSC + 2.44" TSC + 2.44"	25(0.62V) 20(0.58V)	47.6 42.6	63.1 58.1	N/a 41 Max
R7 C49	1995 1999	TSC + 5.47" TSC + 4.27" TSC + 5.47" TSC + 4.27"	25(0.18V) 31(0.71V) 2(0.19V) 24(0.72V)	47.6 53.6 24.6 46.6	63.1 69.1 40.1 62.1	N/a N/a ----- 13 Max

**Table 3 Summary of Pit Indications – “C” Steam Generator – Spring 1996**

Row / Column	Insp. Date	Location	% TW (Bobbin) 400 Khz	% TW + 22.6 % (Total NDE Uncertainty Based On Standard Deviation)	% TW + 38.1% (Total NDE Uncertainty Based on 95/95 Probability Distribution)
R25 C13	1979	NDD	NDD	N/a	N/a
	1996	TSC + 2.2"	26(1.26V)	48.6	64.1

### Other

A previous concern with the “dinged” row 1 tubes at the top-of-tubesheet intersection (e.g., “A” S/G, R1 C36) is now a closed issue. All steam generators have now been inspected since the phenomenon was judged to have occurred. All identified tubes exhibiting this phenomenon have been removed from service.

### Summary and Conclusion

Overall condition assessments have been delineated in the Surry Steam Generator Monitoring and Inspection Program Plan. Performance criteria are established in this document in three areas:

- Tubing Structural Integrity
- Operational Leakage
- Projected Accident Leakage

Condition monitoring and operational assessment of the steam generator tube bundles are performed to verify that the condition of the tubes as reflected in the inspection results is in compliance with the plant licensing basis. Defects detected are evaluated to confirm that the Reg. Guide 1.121 margins against leakage and burst were not exceeded at the end of the operating cycle using the bounding assessment method. The results of the condition monitoring evaluation are used as a basis for an operational assessment which demonstrates prospectively that the anticipated performance of the steam generators will not exceed the Reg. Guide 1.121 margins against leakage and tube burst during the ensuing operating period.

The inspection performed on the “A” steam generator was consistent with the Program Plan and the results formed the basis of the condition monitoring and operational assessment performed for this outage. This condition monitoring and operational assessment for tube integrity follows the requirements of the EPRI GC-107621 (draft), “Steam Generator Integrity Assessment Guidelines,” dated December 1998.

The two (2) degradation mechanisms identified to date are wear at AVB intersections and the recently confirmed free span pitting. Neither of these mechanisms is considered “active” based on industry guidelines. Acceptable tube integrity at the end

of the current operating cycle is demonstrated in this report, and condition monitoring and operational assessment requirements on burst pressure and accident condition leak rates are satisfied for all degradation mechanisms found during the inspection. All indications found were below their associated structural limits including 3 delta P burst pressure margins for free span pits. The total potential past cycle leakage at steam line break (SLB) is estimated to be zero for the free span pits.

The condition of the Surry Unit 2 steam generators, as indicated by the results of the condition monitoring evaluation, satisfy the requirements of Reg. Guide 1.121 with respect to structural and leakage integrity margin. Evaluation of each of the observed tube degradation mechanisms showed no or low progression rates over the last operating interval of 44.2 EFPM. Projection of degradation rates for the next planned operating interval of 48.2 EFPM for the "A" steam generator does not indicate that conditions exceeding structural and leakage margin requirements would occur before the end of the next planned operating interval. Thus, the operational assessment requirements are satisfied.

Confirmation on pit indications in "A" steam generator prompted the entry and plugging of the one previously called pit indication on "C" steam generator. No other findings from the balance of the eddy current results on "A" steam generator required any expansion of testing to other steam generators, and the results were consistent with previous eddy current results on "B" and "C" steam generators. Hence, the operational assessment requirements continue to be met for these generators and no changes to their currently planned tubing inspection interval are necessary. "C" steam generator is scheduled for inspection in the fall of 2000 and "B" for the spring of 2002.

These conclusions are further confirmed by the lack of observed primary-to-secondary leakage during the last operating cycle as determined by routine monitoring.

### **Secondary Inspections**

No items were identified during the current completed inspection efforts that would impact the structural and leakage performance of the Unit 2 steam generators through the next planned operating interval, thereby satisfying the operational assessment.

### **Corrective Actions Planned**

None

### **Evaluation (If SG condition does not meet previous cycle operational assessment)**

Not Applicable