VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

March 30, 1998

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

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NL&OS/MWH	R0
Docket Nos.	50-280, 281
	50-338, 339
License Nos.	DPR-32, 37
	NPF-4, 7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
NORTH ANNA POWER STATION UNITS 1 AND 2
NRC GENERIC LETTER (GL) 97-06: DEGRADATION OF STEAM GENERATOR INTERNALS

On December 30, 1997, the Nuclear Regulatory Commission issued Generic Letter 97-06, "Degradation of Steam Generator Internals." The generic letter requested that licensees provide the following information: (1) Discussion of any program in place to detect degradation of steam generator internals and a description of the inspection plans, and (2) If no program is currently in place to detect degradation of steam generator internals, then include a discussion and justification of the plans and schedule for establishing a program, or why no program is needed.

Virginia Electric and Power Company's response is provided in Attachment A.

No commitments are being made in this letter. Should you have any questions, please contact me.

Very truly yours,

James P. O'Hanlon
Senior Vice President - Nuclear

A061

Attachment

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

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

Mr. M. J. Morgan
NRC Senior Resident Inspector
North Anna Power Station

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by J. P. O'Hanlon, who is Senior Vice President - Nuclear, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 30TH day of March, 1998.

My Commission Expires: March 31, 2000.

Maggie McClure
Notary Public

(SEAL)

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Virginia Electric and Power Company Comments
NRC Generic Letter 97- 06: Degradation of S/G Internals

1.0 Introduction

Generic Letter (GL) 97-06, "Degradation of Steam Generator Internals" was issued to: (1) alert addressees to the previously communicated findings of damage to steam generator internals, namely, tube support plates and tube bundle wrappers, at foreign PWR facilities; (2) alert addressees to recent findings of damage to steam generator tube support plates at a U.S. PWR facility; (3) emphasize to addressees the importance of performing comprehensive examinations of steam generator internals to ensure steam generator tube structural integrity is maintained in accordance with the requirements of Appendix B to 10 CFR Part 50; and (4) require all addressees to submit information that will enable the NRC staff to verify whether addressees' steam generator internals comply with and conform to the current licensing bases for their respective facilities.

NRC Request

Each licensee is required to provide a written report that includes the following information:

(1) Discussion of any program in place to detect degradation of steam generator internals and a description of the inspection plans, including the inspection scope, frequency, methods and equipment.

The discussion should include the following information:

(a) Whether inspection records at the facility have been reviewed for indications of tube support plate signal anomalies from eddy current testing of the steam generator tubes that may be indicative of support plate damage or ligament cracking.

(b) Whether visual or video camera inspections on the secondary side of the steam generators have been performed at the facility to gain information on the condition of the steam generator internals (e.g., support plates, tube bundle wrappers, or other components).

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(c) Whether degradation of steam generator internals has been detected at the facility, and how the degradation was assessed and dispositioned.

(2) If the addressee currently has no program in place to detect degradation of steam generator internals, discussion and justification of the plans and schedule for establishing such a program, or why no program is needed.

This response provides information for Surry Units 1 & 2 and North Anna Units 1 & 2 requested by the GL. The information requested includes discussions on item (1). Item (2) is considered not applicable since inspection programs are conducted on a routine basis for the referenced units.

2.0 Virginia Electric and Power Company Response

2.1 Background

Prior to issuance of the GL, the Westinghouse Owners Group (WOG), the Electric Power Research Institute (EPRI), and the Nuclear Energy Institute (NEI) developed an action plan to assess the susceptibility to secondary side degradation. Virginia Electric and Power Company (Virginia Power) intends to follow the industry action plan. Included in the action plan is a requirement to understand the causal factors involved in the degradation experienced in the French units. This information is captured in EPRI report GC-109558, "Steam Generator Internals Degradation: Modes of Degradation Detected in EDF Units". This report was submitted to the NRC via NEI letter, dated December 19, 1997 for information.

The WOG has reviewed EPRI GC-109558 relative to the design of 51 Series steam generators and determined limited potential susceptibility. For plants with 51 Series steam generators, this conclusion is documented in report WCAP-15002, Rev. 1, "Evaluation of EDF Steam Generator Internals Degradation – Impact of Causal Factors on Westinghouse 51 Series Steam Generators", December 1997. The 51 Series includes Westinghouse model designations 51, 51M, 51F, and 54F and thus includes the Surry 51F model and the North Anna 54F model.

The referenced WCAP documents these evaluations and the results of an industry survey of visual inspections of many plants. It was concluded that based on the results

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of these evaluations and the survey inspection results, the causal factors identified by EDF do not have immediate impact on the continued operability of Westinghouse 51 Series steam generators. In addition, eddy current inspection of the tubes would detect any detrimental effects on the tubing due to wear caused by tube support plate (TSP) ligament degradation, loose parts, and secondary side flow distribution changes. Foreign object searches are also conducted to discover loose parts after steam generator sludge lancing.

2.2 Summary of WOG Study

As discussed in WCAP-15002, Rev. 1, surveys were sent to WOG utilities requesting the results of steam generator secondary side inspections and relevant tube inspections for tube support plate conditions. Completed surveys were received for 37 of 49 plants which included a variety of steam generator models. For the 51 Series steam generators, responses were received for 18 plants. Of these, 16 responded as having inspected or reviewed inspection data for TSP ligament indications and 11 having performed SG secondary side entries that give confidence of not having a wrapper drop occurrence. TSP ligament indications were reported for 468 ligaments in TSPs made of carbon steel with round tube holes and flow holes. The total number of applicable tubes is on the order of 129,000 tubes with roughly 3.6 million ligaments. There is no report of any ligament damage indications for the stainless steel TSPs.

The modes of degradation detected include cases of erosion-corrosion (flow-assisted corrosion) and of premature cracking that results from either surface fatigue or from corrosion cracking associated with surface conditions such as pitting or geometric concentrations. However, the surveys do not report detection of modes of degradation similar to that experienced in the EDF units. There is no evidence of post chemical cleaning inspections discovering any significant material losses. There is no evidence of any wrapper having dropped. There is no evidence of a progressive and/or continuing condition of TSP ligament cracking or thinning. TSP ligament cracking or missing pieces of ligaments have been observed, but only in units with carbon steel support plates with drilled round tube holes and flow holes. These conditions are generally traceable to initial inspections and are not progressing based on sequential inspection data. Many of the conditions are judged to be related to original TSP drilling alignment. There are some cases of indications in carbon steel TSPs that have been linked to patch plate welds.

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Plants with significant hour-glassing of the tube support plates as a result of the denting process have exhibited ligament cracking throughout the thickness of the support plate between the flow holes in the plate or the flow holes in the tube lane. If denting remained uncontrolled, as subsequent support plate corrosion occurs, the potential exists for fragments of the support plate material to become completely free of the main TSP structure. However, these plate segments generally remain locked in place because of the in-plane forces that give rise to denting, as well as the deformation that contains the individual piece. Operating plants with active denting are under periodic monitoring by the utility and have long-standing acceptance criteria which has been submitted to the NRC. In addition, the EDF experiences reported are not related to support plate degradation that has progressed to the tube denting stage. These plants are therefore not included in the evaluation in the referenced WCAP.

The secondary side internal degradation types found in Westinghouse 51 Series steam generators and relative susceptibilities within this series of steam generators are identified in the attached Table 1.0. This information is documented in the referenced WCAP. Surry Units 1 and 2 have Model 51F steam generators and North Anna Units 1 and 2 have Model 54F steam generators. Both models have quatrefoil flow openings around the tube and stainless steel TSPs.

2.3 Plant Specific Inspection Results

An inspection summary for inspections that have been conducted at the Surry units is included in Table 2.1 and for the North Anna units is included in Table 2.2. A supplemental discussion is provided to note any unique findings and address specifically items (1) (a) and (b) of the NRC's request.

As indicated in the table, limited degradation has been observed with the most susceptible areas being monitored during the periodic secondary side inspections. With regards to item (1)(a), past eddy current records were not reviewed in detail for signs of TSP ligament cracking since this technique is not used on quatrefoil designs. However, eddy current findings will be able to clearly distinguish gross displacements of TSPs or missing pieces. No such findings have been observed to date on any inspections. In addition, this mode of degradation is extremely remote on stainless steel TSPs.

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Relative to item (1)(b), the summary and results of inspections has been included in Tables 2.1 and 2.2 with unique findings annotated.

2.4 Safety Assessment

The following safety concerns were evaluated in the Westinghouse Owners Group study in the referenced WCAP relative to the French steam generator internals degradation experience. They were:

- Loss of supports leading to tube wear and possible primary-to-secondary leakage or inadequate burst margins.

- More significant tube support plate deformation during a postulated LOCA + SSE event resulting in unacceptable steam generator tube collapse or secondary-to-primary in-leakage.

- The generation of a loose object in the secondary side of a steam generator which may result in tube wear or impacting with the potential for primary-to-secondary leakage.

Based on a review of Table 1.0, the only degradation types that may occur domestically and that may result in the loss of tube support plate integrity are: TSP flow hole/ligaments erosion-corrosion, TSP ligament cracking near the patch plates, and TSP ligament cracking in random areas. There are no observations of post chemical cleaning inspections discovering any significant material losses. There are no observations of any wrappers having dropped. There are no observations of TSP ligament cracking or thinning that is progressive and/or continuing. TSP ligament cracking or missing pieces of ligaments have been observed, but only in units with carbon steel TSPs with drilled round tube holes and flow holes. Utilities with 51 Series steam generators with carbon steel support plates inspect a significant percentage of steam generator tubes every outage with a bobbin probe, eddy current examination. If sections of the tube support plate are missing, this would be readily detectable due to a lack of eddy current response at the tube support plate elevation and actions can be taken to address the absence of the support. Future application of the voltage-based plugging criteria will also consider the presence of any missing ligaments. The alternate plugging criteria would not be applied at these locations.

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There is no increased susceptibility to ligament cracking near the wedge supports in the 51 Series steam generator designs because either there are no flow holes extending to the periphery at the wedge locations or the wedges are not welded to the TSPs, as is the case with the EDF 51M steam generator. Existing calculations evaluating the effects of LOCA + SSE loadings on the tube bundle continue to apply.

Another occurrence resulting from steam generator internals degradation that may affect a steam generator from performing its intended safety function is the potential for tube wear and primary-to-secondary leakage due to the generation of a loose object on the secondary side of the steam generator. This may occur due to erosion-corrosion of the moisture separators, feed ring/J-tube, or tube support plate flow holes, or the occurrence of tube support plate ligament cracking. These areas are currently being monitored by the industry. If primary-to-secondary leakage should occur due to tube wear from a loose object, the expected consequences would be bounded by a single tube rupture event and, therefore, would remain within the current licensing bases of a plant. Regardless, it is Virginia Power's position that loose objects should be removed from the steam generator, whenever possible. Remaining objects that appear fixed or locked must be evaluated and dispositioned before being allowed to remain. In addition, tubes observed to have visible damage should be eddy current and plugged if found to be defective. Eddy current inspection, foreign object search and retrieval (FOSAR) activities during refueling outages and loose parts monitors provide defense in depth to ensure the maintenance of tube integrity during subsequent plant operation.

For the types of steam generator internals degradation observed at Surry and North Anna, it is expected that the degradation would be limited in extent such that the tubes will remain capable of sustaining the conditions of normal operation, including operational transients, design basis accidents, external events, and natural phenomena permitting the affected steam generator to perform its intended safety function.

2.5 Inspection Plan: (Surry Units 1&2 - Model 51F)

Based on previous inspection findings and the referenced evaluations for the susceptibility of degradation on the Surry model units, the following types of inspections are planned as a part of the continuing secondary side inspection program (Ref. 2).

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Inspection scope and frequency may be adjusted, as necessary, based on site specific experience and evaluation of industry results of these inspections.

1. Tube Support Plate Ligament Erosion/Corrosion and Cracking

Since the steam generators have stainless steel tube support plates with quatrefoil broached hole design, eddy current detection of potential ligament cracking is not applicable. A number of studies have reported that the chromium content in carbon steel has a significant effect on resistance to an erosion/corrosion mechanism. The chromium content of stainless steel support plates is expected to preclude the occurrence of this degradation mechanism.

A sample visual inspection of the top tube support plate is currently planned to be conducted during the next scheduled inspection of the tube bundle area of a Surry 51F steam generator. The tube lane region where flow holes are provided instead of elongated slots will be integrated with this visual examination. Flow holes are used to provide strengthening of the top TSP for U-bend support. If initial drilling produced a separated ligament, an evaluation of the effect on U-bend support will be made. This sample inspection is currently planned for the Unit 1 refueling outage in the fall of 1998.

2. Wrapper Drop

It will be verified that the sludge lance equipment can be inserted without interference. The frequency of tubesheet cleaning at Surry is typically every other refueling outage.

If interference with the sludge lance equipment is detected that is deemed associated with this issue, the lower wrapper support blocks will be visually inspected. The next tubesheet cleaning is currently planned for the Unit 2 outage in the spring of 1999.

3. Wrapper Cracking

No inspection is recommended unless evidence of wrapper misposition or tube damage in the periphery of the first tube support plate is detected. If degradation is

detected, a visual inspection of the lower wrapper support blocks will be conducted consistent with the inspection referenced in Item 2, Table 2.1 (Wrapper Drop).

4. Upper Package

The areas of focus in the steam drum are the primary and secondary moisture separators and the feed ring with associated components (i.e., J-tubes, carbon steel feed ring adjacent to J-tubes, T-section, reducers, backing rings, and the thermal sleeve).

There has been previous correspondence on these issues in the form of vendor bulletins and NRC Information Notices. Suspect areas are being monitored as a part of the steam generator secondary side inspection program and these areas are typically inspected in one steam generator each refueling outage. The next inspection is currently planned for the Unit 1 outage in the fall of 1998.

5. Transition Cone Girth Weld

These welds are inspected in accordance with the scope and frequency requirements of the steam generator shell, Section XI In-Service Inspection requirements.

2.6 Inspection Plan: (North Anna Units 1&2 - Model 54F)

Based on previous inspection findings and the referenced evaluations for the susceptibility of degradation of the North Anna units, the following types of inspections are planned as a part of the continuing secondary side inspection program (Ref. 3). Inspection scope and frequency may be adjusted, as necessary, based on site specific experience and evaluation of industry results of these inspections.

1. Tube Support Plate Ligament Erosion/Corrosion and Cracking

Since the steam generators have stainless steel tube support plates with the quatrefoil broached hole design, eddy current detection of potential ligament cracking is not applicable. A number of studies have reported that the chromium content in carbon steel has a significant effect on resistance to an erosion/corrosion mechanism. The

chromium content of stainless steel support plates is expected to preclude the occurrence of this degradation mechanism.

A sample visual inspection of the top tube support plate is currently planned to be conducted during the next scheduled inspection of the tube bundle area of a North Anna 54F steam generator. The tube lane region where flow holes are provided instead of elongated slots will be integrated with this visual examination. Flow holes are used to provide strengthening of the top TSP for U-bend support. If initial drilling produced a separated ligament, an evaluation of the effect on U-bend support will be made. This sample inspection is currently planned for the Unit 2 refueling outage in the Fall of 1999.

2. Wrapper Drop

It will be verified that the sludge lance equipment can be inserted without interference. The frequency of tubesheet cleaning at North Anna is typically every other refueling outage.

If interference with the sludge lance equipment is detected that is deemed associated with this issue, the lower wrapper support blocks will be visually inspected. The next tubesheet cleaning is currently planned for the Unit 1 outage in the fall of 1998.

3. Wrapper Cracking

No inspection is recommended unless evidence of wrapper misposition or tube damage in the periphery of the first tube support plate is detected. If degradation is detected, a visual inspection of the lower wrapper support blocks will be conducted consistent with the inspection referenced in Item 2, Table 2.2 (Wrapper Drop) .

4. Upper Package

The areas of focus in the steam drum are the primary and secondary moisture separators and the feed ring with associated components (i.e. J-tubes, carbon steel feed ring adjacent to J-tubes, T-section, reducers, backing rings, and the thermal sleeve).

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There has been previous correspondence on these issues in the form of vendor bulletins and NRC Information Notices. Suspect areas are being monitored as a part of the steam generator secondary side inspection program and these areas are typically inspected in one steam generator each refueling outage. The next inspection is currently planned for the Unit 2 outage in the spring of 1998.

5. Transition Cone Girth Weld

These welds are inspected in accordance with the scope and frequency requirements of the steam generator shell, Section XI In-Service Inspection requirements.

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Table 1.0
Susceptibility to Secondary Side Internals Degradation in Westinghouse 51 Series SG Designs

Degradation Type	Level of Susceptibility
Erosion Corrosion:	
Moisture Separator	X
TSP Quatrefoil Ligaments	N
TSP Flow Hole/Ligaments	L
Feed Ring/J-Tubes	X
Cracking:	
TSP Ligaments Near Wedges(2)	N
TSP Ligaments Near Patch Plates	X(1)
Carbon Steel TSP Ligaments (Random Areas)	X(1)
Wrapper Near Supports(2)	N
Transition Cone Girth Weld	X
Other:	
Wrapper Drop(2)	N

X = Observed in some SGs
N = Not Susceptible to EDF Causal Factors
L = Low Susceptibility to EDF Causal Factors

(1) Various indications of degradation may be artifacts of manufacturing related to patch plate plug welds and/or drilling alignment.

(2) Various Westinghouse design features are beneficial relative to some of the steam generator design features of foreign manufacturers.

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Table 2.1
SG Inspection Summary for Surry Units 1 and 2

Component	Location			Condition			Type of Inspection
	Row	Column	Elev	Cracked	Missing	E/C	
Tube Support Plates	Not Applicable			No degradation identified			Pre and post chemical cleaning (CC) video inspections with telescoping flow slot camera (Unit 2) Pre CC - Unit 1
	Lower	Upper	Seam	Cracked	Deform	Drop	
Wrapper	Yes	No	No	No degradation identified			Visual inspection during sludge lance (S/L) activities. During recent wrapper access mods on both units (enlarging for S/L equip.), no misalignment noted.
	Shell	TSPs	Other	Pitting	Wastage	Crack	
Chemical Cleaning	Yes	No	Yes	No degradation identified			Most susceptible mat'l monitored with multiple corrosion monitoring methods (on-line, grab samples, & coupons). Mat'ls Monitored: A533 - Shell A508 - Tubesheet A285 - Wrapper
				Pitting	Wastage	Crack	
Other Secondary Side: Girth Weld (Old Upper shell to Transition Cone)				Yes	No	Yes	1985 Issue closed out, req'd augmented inspections completed.
Feed Ring				No	Yes	No	UT and internal camera inspections.
J-Tubes				No	No	No	UT confirmed no thinning on Inconel.
Riser Barrels				No	Yes	No	Upper barrels by swirl vanes replaced during separator mods. Other areas being monitored.

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Table 2.2
Inspection Summary for North Anna Units 1 and 2

Component	Location			Condition			Type of Inspection
	Row	Column	Elev	Cracked	Missing	E/C	
Tube Support Plates	1	Various	TSP 5, 6, & 7	No degradation identified			Unit 1 - Remote video camera insp. thru 7th TSP tube lane inspection port. Unit 2 – Future inspection.
	Lower	Upper	Seam	Cracked	Deform	Drop	
Wrapper	Yes	No	No	No degradation identified			Visual inspection during sludge lance (S/L) activities, no mis-alignment noted. Note: Recent S/G Repl. Unit 1 - 1993 Unit 2 - 1995
				Pitting	Wastage	Crack	
Other Secondary Side: Girth Weld(Old Upper Shell to TransitionCone)				No degradation identified			Augmented surface inspections between 1986 and 1990 as a part of industry experience bulletins.
Feed Ring				No	Yes	No	UT and internal camera inspections Note: Localized I. D. thinning warranted replacement of 2 of 3 feed rings during Unit 2 S/G replacement.
J-Tubes				No	No	No	UT confirmed no thinning on Inconel.
Riser Barrels				No degradation identified			Visual exam during planned inspections

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References

1. WCAP-15002, Rev. 1, "Evaluation of EDF Steam Generator Internals Degradation - Impact of Causal Factors on Westinghouse 51 Series Steam Generators"

2. SPS - SGMIPP - 001, Rev. 1, December 1997, Surry Steam Generator Monitoring and Inspection Program Plan

3. NAPS - SGMIPP - 001, Draft Rev. 0, June 1997, North Anna Steam Generator Monitoring and Inspection Program Plan