Public Service
Electric and Gas
Company

Louis F. Storz
Senior Vice President - Nuclear Operations

Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609-339-5700

MAR 3 0 1998
LR-N980141

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

90 DAY RESPONSE TO GENERIC LETTER 97-06
STEAM GENERATOR TUBE INSPECTION TECHNIQUES
SALEM GENERATING STATION
FACILITY OPERATING LICENSE NOS. DPR-70, DPR-75
DOCKET NOS. 50-272, AND 50-311

This letter provides the 90 day response to Generic Letter 97-06 for the Salem Generating Station. Public Service Electric and Gas Company (PSE&G) has reviewed the generic letter requirements, and provides its response in attachment 1 to this letter.

Should you have any questions or comments on this transmittal, do not hesitate to contact us.

Sincerely,

Louis F Storz

Attachment (2)
Affidavit

MAR 3 0 1998

C Mr. H. J. Miller, Administrator - Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. P. Milano, Licensing Project Manager - Salem
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop 14E21
Rockville, MD 20852

Ms. M. Evans
USNRC Senior Resident Inspector (X24)

Mr. K. Tosch, Manager IV
Bureau of Nuclear Engineering
33 Arctic Parkway
CN 415
Trenton, NJ 08625

REF: LR-N980141

STATE OF NEW JERSEY)
) SS.
COUNTY OF SALEM)

L. F. Storz, being duly sworn according to law deposes and says:

I am Senior Vice President - Nuclear Operations of Public Service Electric and Gas Company, and as such, I find the matters set forth in the above referenced letter, concerning the Salem and Hope Creek Generating Stations, are true to the best of my knowledge, information and belief.

Louis F Storz

Subscribed and Sworn to before me
this 30th day of March 1998

Kimberly Jo Brown
Notary Public of New Jersey

KIMBERLY JO BROWN
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires April 21, 1998

My Commission expires on _____

ATTACHMENT 1
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

INTRODUCTION:

Generic Letter 97-06 (GL), "Degradation of Steam Generator Internals" was issued to request licensees to (1) again 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.

This response provides information for Salem Generating Station requested by the GL. The information requested includes:

(1) A discussion of any program in place to detect degradation of steam generator internals and descriptive inspection plans, including the inspection scope, frequency, methods and equipment. The GL requires discussions to include the following information for each facility:

   (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).
   (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."

Prior to issuance of the Generic Letter, 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

similar to the type experienced at some Electricite de France (EdF) plants. 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.

The Westinghouse Owners Group has reviewed EPRI GC-109558 relative to the design of 51 Series steam generators and determined limited susceptibility. The 51 Series designs are the most similar to the EdF units. For plants with 51 Series steam generators, this conclusion is documented in report WCAP-15002, "Evaluation of EDF Steam Generator Internals Degradation – Impact of Causal Factors on Westinghouse 51 Series Steam Generators", December 1997.

WCAP-15002 documents the results of steam generator secondary side inspections and relevant tube inspection for tube support plate (TSP) conditions of WOG plants. WCAP-15002 concluded that the number of plants that have been inspected and the inspection results demonstrates that the causal factors identified by EdF do not jeopardize the continued operability of Westinghouse 51 Series steam generators. Eddy current inspection of the tubes would detect any detrimental effects on the tubing due to wear caused by TSP ligament degradation, loose parts, and secondary side flow distribution changes. Foreign object search and retrieval efforts are routinely performed to discover loose parts.

A response to item 1 of the Generic Letter has been completed for Salem Unit 2, which has Model 51 Steam Generators, addressing subsequent plant operation with potential steam generator internals degradation of the types experienced in the French Units (and other types of degradation experienced domestically and is provided in Attachment 1). Item 2 of the Generic Letter does not apply.

A detailed evaluation has not been completed by the WOG for the Model F replacement steam generators installed in Salem Unit 1. The Salem Unit 1 steam generators are currently in as-new condition and have not yet been operated at power. The Model F detailed evaluation is expected to be completed by the WOG the end of May of 1998. An inspection plan will be developed for implementation during Refueling Outage 13. To the extent possible, a response to item 1 for the Model F steam generators is provided in Attachment 2.

ATTACHMENT 1
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

Response to GL Item 1 for Salem Unit 2 - Westinghouse 51 Series Steam Generators

Item 1

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

Background

As discussed in WCAP-15002, surveys were sent to all 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 plant sites. For the 51 Series steam generators, responses were received for 18 plants. Of these, 16 responded as having inspected or reviewed inspection data for Tube Support Plate (TSP) ligament indications and 11 having performed SG secondary side entries that give confidence of not having wrapper drop. TSP ligament indications are reported for 468 ligaments in TSPs made of carbon steel with round, tube holes and flow holes. The total number of tubes involved is on the order of 129,000 tubes with roughly 3.6 million ligaments. There is no report of any ligament damage or indications in the stainless steel, quatrefoil TSPs.

The modes of degradation detected include many cases of flow-assisted corrosion, or erosion-corrosion, and of premature cracking that results from either surface fatigue or from corrosion cracking, that is associated with surface conditions such as pitting or geometric concentrations. For the most part, however, the surveys do not report detection of several modes of degradation 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 TSP ligament cracking or thinning that is progressive and continuing. TSP ligament cracking or missing pieces of ligaments have been observed, but only in units with carbon steel support plates with drilled round 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 probably related to drilling alignment. There are cases of indications in TSPs that have been linked to patch plate welds. Per WCAP 15002, the secondary side internal degradation types applicable to 51 Series steam generators are identified in Table 1. Site-specific results are tabulated in Table 2.

ATTACHMENT 1
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

Table 1
Secondary Side Internal Degradation Types in Westinghouse 51 Series Steam Generators
(Feedring Carbon Steel TSPs)

Degradation Type	Susceptibility
Erosion-Corrosion:	
Moisture Separator	X
Water Box	NA
TSP Flow Hole/Ligaments	S
Feed Ring/J-Tubes	X
Cracking	
TSP Ligaments(1),(2)	X
Wrapper Near Supports(2)	L
Transition Cone Girth Weld	X
Other	
Wrapper Drop(2)	L

X= *Observed in some steam generators*
S = *Susceptible*
L = Low Susceptibility
NA = Not Applicable
(1) *Various indications of possible tube degradation may be artifacts of manufacturing anomalies related to patch plate welds and drilling alignment*
(2) *Various Westinghouse design features are beneficial relative to the modifications incorporated in some steam generators of foreign manufacturers.*

ATTACHMENT 1
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

Table 2: Salem Unit 2 Inservice Inspection Results

Component	Location			Condition		Inspection Type
	Row	Column	Elev.	Cracked	Missing	
Tube Support Plates						
22 S/G	37	54	3H	Y		Eddy Current
	41	54	3H	Y		Eddy Current
23 S/G	9	40	6C	PSI		Eddy Current
	45	54	7H	Y		Eddy Current
	46	54	7H	Y		Eddy Current
	39	56	7H	Y		Eddy Current
	14	57	5C	PSI		Eddy Current
	22	75	1H		X	Eddy Current
	29	81	7C	PSI		Eddy Current
	29	81	1C	PSI		Eddy Current
24 S/G	41	39	2C	PSI		Eddy Current
	46	41	1H	Z		Eddy Current
Other Secondary Side						
Girth Welds	as identified in Section XI program			No findings		Per ASME Sect. XI requirements
Feedring	all steam generators during 1996 outage			acceptable		Direct Visual and UT thickness
J-Tube	all steam generators during 1996 outage			acceptable		Direct Visual and dimensional checks
Riser Barrels	all steam generators during 1996 outage			acceptable		Visual (Video probe)
Support plate inspection	all steam generators during 1996 outage			acceptable		Visual (Video probe)
Post sludge lancing Cleanliness Inspection/FOSAR	all steam generators during 1996 outage			acceptable		Visual (Video probe)
Inbundle visual inspection	all steam generators during 1996 inspection			Objects retrieved when possible. Remaining objects evaluated per 10CFR50.59.		Visual (Video probe) & Eddy Current

LEGEND

PSI - Possible support indication as identified by bobbin, no MRPC data available
Y - Bobbin PSI, confirmed with MRPC as single crack
X - Bobbin PSI, confirmed with MRPC as missing ligament
Z - Bobbin PSI, confirmed with MRPC as multiple cracks without missing ligament

ATTACHMENT 1
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

Tube Support Plates

Salem Unit 2 has been in operation since initial startup without any incident attributed to deficiencies in the condition of the tube support plates. In January of 1998, a baseline was established from the 2R9 low frequency bobbin data to determine the likelihood that irregularities were present in the Unit 2 SG support plates. This baseline program was is consistent with that specified in WCAP-15002 for Steam Generators with carbon steel tube support plates. The results of this baseline screening revealed 12 tube support plate intersections as possible support indications (PSI). An evaluation of historical data was performed to determine if active TSP degradation mechanisms are present. Data between 1984 and 1994 were acquired at 10 kHz. The 1996 inspection was performed at 20 kHz, so there is difficulty with comparison of the historical data and that acquired in the most recent inspection. An examination by a Level III Eddy Current Data Analyst revealed no apparent change in the signal between 1984 and 1994 when the same frequency and test mode (10 Khz absolute) were employed. The differences in the signal between 1996 and previous outages are believed to be due to variances between the signal characteristics between 20 and 10 kHz. The Pre-service ECT data was acquired single frequency therefore these indications could not be tracked back to that time frame.

Seven (7) of the 12 PSI locations were inspected with Plus Point during 2R9 therefore this data was reviewed for characterization. The remaining 5 PSI indications will be inspected with an RPC probe during 2R10 for further characterization. Of the seven (7) locations for which Plus Point data was available, five (5) of the indications exhibited just 1 peak or axial indication. These types of indications are least likely to represent a concern for tube integrity, since there is essentially no chance for the tube to interact with the edges of the discontinuity or to move out of the flow hole. These indications are of negligible impact, however they will be monitored for changes. The five (5) indications exhibiting just 1 peak or axial indication were observed along the patch plate boundary, where a 13 x 14 tube portion of the tube support plate was cut out to facilitate tubing of the SG in the shop; rejoining of the patch plate to the main body of the support plate was accomplished with the insertion of filler welds and button plugs at regular intervals along the patch plate boundary. Some of the PSI signals are likely representative of variations in the weld/tube hole ligament geometry. No impact on tube integrity is anticipated since the patch plate cuts run through the center of the flow holes thus not directly involving the tube hole ligaments.

Two (2) MRPC (plus point) indications exhibited 2 peaks representing the possibility of multiple ligament cracks or missing ligament section. One indication was confirmed to

have a measured gap of 38°. Based on PSE&G's review of available plus point data it was determined no tube wear or degradation was coincident with the missing ligament observations. This result corroborates the expectation that ligament gaps of the sizes observed from the ECT data are not large enough to permit tube motion due to vibration sufficient to induce wear. The other multiple peak indication was determined not to relate to a missing ligament based on eddy current results. In light of the presence of denting at Salem Unit 2 steam generators, it is likely that the gaps between the tubes and the tube holes are packed with corrosion products; this reduces further the likelihood that tube motion might be amplified in presence of ligament gaps. Westinghouse performed evaluations for Farley and Diablo Canyon Nuclear Power Plants, both of which have the same design steam generators (51 Series) as Salem 2, and determined that ≥ 145° of missing ligament support is required to have an unsupported condition. In the absence of indicated tube degradation and in light of the small size (38°) of the suspected missing ligament it is judged that the affected tubes did not challenge Reg. Guide 1.121 limits during cycle 9 and there is no expectation that tube degradation associated with this condition will approach Reg. Guide 1.121 limits in cycle 10.

Loose Parts

In January, 1996, a visual inspection and foreign object search and retrieval was performed on Salem 2 using a video probe. 100% of tubesheet in-bundle was performed for all steam generators. Annulus and blowdown lanes were also inspected. Foreign objects were found in the 22, 23, and 24 steam generators. These objects were retrieved. Some objects that could not be retrieved in the past were left in the steam generators after being evaluated in accordance with 10 CFR 50.59. Tube support plate inspections were performed through both handholes on the 21 and 23 steam generators, through the second and third flow slots. The 22 and 24 steam generators were inspected through a single handhole only, using the third flow slots.

Steam Generator Wrapper

There have been no specific inspections performed on the wrapper supports. Sludge Lancing/Foreign Object Search and Retrieval (FOSAR) is performed each refueling outage in accordance with Salem's work control program and no equipment interferences have been identified. Due to design differences between the EdF SG's and the Westinghouse 51 Series SG there is no concern for wrapper drop therefore a specific inspection program for the wrapper supports is not necessary at this time. WCAP-15002 states that the ability to insert sludge lancing equipment with no interference is an adequate check to verify wrapper drop has not occurred. Salem has

sludge lanced during the 2R9 outage, so wrapper drop would have been detectable if it had occurred.

Inspection Frequency

Salem's work control process is used for performing SG upper internals package (J-tubes, feedring, riser barrel, moisture separators, etc.) inspections. The current frequency for inspection is on a refueling outage basis. All steam generators were inspected during the 1996 outage. A follow-up inspection will be performed on each steam generator during the next refueling outage. These results will be used to assess future inspection requirements. Since the significance of tube integrity as a result of degradation of these components is loose parts, Salem's loose parts monitoring and foreign object search and retrieval inspection programs ensure that tube integrity is maintained during plant operation. FOSAR inspections are performed after sludge lancing during refueling outages. Tube support plate ligament inspections will be performed in conjunction with eddy current inspections.

Safety Assessment

The following safety concerns have been identified relative to the French steam generator internals degradation experience. These are:

- Loss of support leading to steam generator tube wear and possible primary-to-secondary leakage due to excessive vibration amplitudes or inadequate burst margins for plants implementing a voltage-based plugging criteria for tubes experiencing outside diameter initiated stress corrosion cracking at the tube support plate intersections.

- 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 that may result in tube wear and possibly primary-to-secondary leakage.

Based on a review of Table 1, the only degradation types that may occur domestically and 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. Failure of a TSP during normal operating conditions and the subsequent generation of loose object(s) and potential resultant tube wear would not

result in a condition beyond the plant licensing basis (see below). Failure of a TSP ligament during a postulated steam line break would not be expected to adversely affect steam generator tube integrity due to tube vibration, wear or impact loadings due to the short duration of the transient. There are no observations of post chemical cleaning inspections discovering any significant material losses. There are no observations of any wrapper having dropped. There are no observations of TSP ligament cracking or thinning that is progressive and continuing. TSP ligament cracking or missing pieces of ligaments has been observed, but only in units with carbon steel TSPs with drilled round holes and flow holes. All 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.

There is no increased susceptibility to ligament cracking near the wedge supports in the 51 Series steam generator designs as 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 in determining whether certain tubes should be excluded from application of the voltage-based plugging criteria or whether certain tubes should be removed from service in plants which do not currently apply such a criteria but which may have steam generator tubes experiencing cracking at the tube support plate intersections.

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, feedring /J-tube, or tube support plate flow holes, or the occurrence of tube support plate ligament cracking. If primary-to-secondary leakage should occur due to tube wear from a loose object, the expected consequences would be bounded by the analyzed tube rupture event and, therefore, would remain within the current licensing bases of a plant. In addition, tubes observed to have visible damage should be eddy current inspected and plugged if found to be defective. Eddy current inspection, FOSAR activities during each refueling outage and loose parts monitors should help to ensure the maintenance of tube integrity during subsequent plant operation.

The Salem Unit 2 steam generators are expected to be able to perform their intended safety function, given the types of steam generator internals degradation observed.

Inservice Inspection Plan

Salem Unit 2 expects to follow the inspection plans outlined in WCAP-15002 for tube support plate erosion-corrosion and cracking, wrapper drop and wrapper cracking. Upper internals package (J nozzles, feedring, riser barrel, moisture separators) and foreign object search and retrieval inspections are performed in accordance with the Salem Work Control Program. Transition cone girth welds and feedwater nozzle inspections are performed in accordance with the ASME Section XI program requirements.

ATTACHMENT 2
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

Response to GL Item 1 for Salem Unit 1 Westinghouse Model F Steam Generators

Item 1

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

Background

As discussed in WCAP-15002, surveys were sent to all WOG utilities requesting the results of all steam generator secondary side inspections and relevant tube inspections for tube support plate conditions. No evidence of wrapper drop or ligament damage in the stainless steel quatrefoil TSPs has been reported.

The modes of degradation detected include many cases of flow-assisted corrosion, or erosion-corrosion, and of premature cracking that results from either surface fatigue or from corrosion cracking, that is associated with surface conditions such as pitting or geometric concentrations. For the most part, however, the surveys do not report detection of several modes of degradation experienced in the EdF units. Post chemical cleaning inspections did not reveal any significant material loss of the type reported by EdF.

Discussion of Inspection Results

On August 12, 1996, PSE&G notified the United States Regulatory Commission (USNRC) (Our Ref: LR-N96219) of: 1) its intent to replace the Salem Unit 1 steam generators; and 2) that all activities associated with the original steam generator tube inspections, analysis and testing have been suspended.

The four model 51 Westinghouse steam generators at Salem Unit 1 were replaced with four Westinghouse Model F Steam Generators from the canceled Seabrook Unit 2 plant. The following inspections were performed on the Model F steam generators during the replacement project.

A Foreign Object Search and Retrieval (FOSAR) of the secondary tubesheet face was performed to record the general condition of the lane and annulus areas and to determine if loose parts were present. Examination results were acceptable.

ATTACHMENT 2
RESPONSE TO GENERIC LETTER 97-06
LR-N980141

A visual inspection of the upper secondary side steam drum was performed to detect signs of damage or degradation. Specific components inspected were the moisture separator, dryers, drain lines, feedring and structural supports. The overall results of the inspection were satisfactory. The following modifications were made during the steam generator replacement project.

- The carbon steel feedwater header J-tubes were replaced with Inconel alloy 600 J-tubes in each steam generator.

- A transition piece was installed in the feedwater nozzles of each SG. The transition pieces were from the original 51 Series steam generators. The purpose of the transition piece is to enhance the feedwater nozzle resistance to the effects of several degradation mechanisms that have been identified for feedwater nozzles, including cracking in the nozzle to piping weld, erosion and corrosion at the thermal sleeve in the flow region and thermal stratification in the nozzle region.

A thorough baseline inspection was performed on the Wrapper Support Structures of the Unit 1 Model F replacement steam generators. The overall objective of the inspections was to obtain information on the design, location and condition of the structural components of the steam generator. The specific components inspected and results are included below:

- Wrapper position blocks
  Visual inspection by video probe of approximately 50% of the wrapper position blocks were inspected and all appeared to be complete with no abnormal conditions noted.

- Back up bar sets
  Inspections by video probe of approximately 40% of back-up bar sets were performed. Other than some minor anomalies that were documented and evaluated acceptable the inspections revealed normal-as-expected conditions.

- Anti-rotation keys
  Inspection by a video probe of a sample of anti-rotation keys was performed. All were intact and complete.

- Tube support plates
  Since the Model F steam generators in Salem Unit 1 have stainless steel tube support plates with the quatrefoil broached hole design, eddy current inspection

of the plate is not applicable in detection of ligament erosion-corrosion or cracking.

Areas on the periphery of the tube support plates with quatrefoil broached openings were visually inspected. No signs of cracking or other fabrication induced degradation was noted.

The top support plate tube lane region in the area of the flow holes was visually inspected on a sample of steam generators. No abnormal conditions were observed.

- Wrapper shell jacking stud sets
  A sample was inspected and no anomalies were noted.

In summary the overall internal structural condition of the Model F replacement steam generators at Salem Unit 1 is satisfactory for operations. The minor anomalies noted are not significant. They were evaluated and found not to adversely impact the design function of the affected structures.

Inservice Inspection Plan and Frequency

The Model F detailed Westinghouse Owners Group evaluation is expected to be issued in May of 1998. Once issued, PSE&G will evaluate the inspection recommendations and determine specific program requirements for detecting degradation of steam generator internals. A formal inspection plan will be completed prior to the Unit 1 thirteenth refueling outage.