



**North  
Atlantic**

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The Northeast Utilities System

March 30, 1998

Docket No. 50-443  
NYN-98047

AR #97031128

United States Nuclear Regulatory Commission  
Attention: Document Control Desk  
Washington, DC 20555-0001

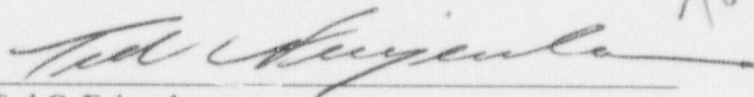
Seabrook Station  
90-Day Response to Generic Letter 97-06

This letter provides North Atlantic Energy Service Corporation's (North Atlantic) 90-day response to Generic Letter (GL) 97-06, "Degradation of Steam Generator Internals." The response provides the requested information regarding the Seabrook Station Steam Generator Model F inspection plan with a summary of inspection results.

Should you have any questions regarding this response, please contact Mr. Terry L. Harpster, Director of Licensing Services, at (603) 773-7765.

Very truly yours,

NORTH ATLANTIC ENERGY SERVICE CORP. 1/1

  
Ted C. Feigenbaum  
Executive Vice President and  
Chief Nuclear Officer A001

cc: H. J. Miller, NRC Regional Administrator  
C. W. Smith, NRC Project Manager, Project Directorate 1-3  
R. K. Lorson, NRC Senior Resident Inspector

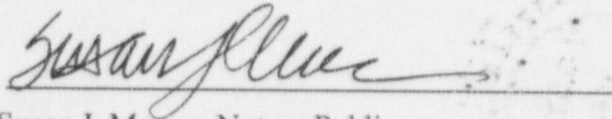
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STATE OF NEW HAMPSHIRE

Rockingham, ss.

March 30, 1998

Then personally appeared before me, Ted C. Feigenbaum, Executive Vice President and Chief Nuclear Officer, North Atlantic Energy Service Corporation that he is duly authorized to execute and file the foregoing information in the name and on the behalf of North Atlantic Energy Service Corporation and that the statements therein are true to the best of his knowledge and belief.

A handwritten signature in cursive script, appearing to read "Susan J. Messer", written over a horizontal line.

Susan J. Messer, Notary Public

My Commission Expires: December 22, 1998

ENCLOSURE TO NYN-98047

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

### **Introduction**

Generic Letter (GL) 97-06, "Degradation of Steam Generator Internals," was issued 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 relevant generic industry information and specific Seabrook Station information requested by the GL. The information requested includes:

- (1) A 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 GL requires 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 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 the 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 steam generator (SG) susceptibility to secondary-side degradation. North Atlantic intends to follow the industry action plan. EPRI's understanding of the

**Response to USNRC Generic Letter 97-06**  
**"Degradation of Steam Generator Internals"**

causal factors involved in the French Units' degradation is captured in the 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 WOG has reviewed EPRI GC-109558 relative to the design Series 51 steam generators and determined limited susceptibility. For plants with Series 51 steam generators, this WOG 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 Series 51 SGs include Westinghouse model designations 51, 51M, 51F, and 54F. Because of a similarity in design, this WOG/WCAP report also covers any implication of susceptibility for two replacement steam generator designs, the Delta 47 and Delta 75. The 51 Series designs were identified as most similar to the EdF units.

WCAP-15002, Rev. 1, documented visual inspections of similar design steam generators. The WCAP concluded the number of steam generators inspected and the inspection results demonstrate that the causal factors identified by the EdF do not jeopardize the continued operability of Westinghouse Series 51 steam generators. The WCAP indicated future 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, or secondary side flow distribution changes. Foreign object search and retrieval efforts are used at plants to discover and recover loose parts.

An industry-sponsored evaluation similar to WCAP-15002 is planned for the remaining types of Westinghouse steam generators (Model 44F, F, D3, D4, D5 and E1/E2). Model F steam generators are installed at Seabrook Station. The Westinghouse detailed evaluation of Model F steam generators is projected for completion by the end of May 1998. North Atlantic will evaluate the inspection recommendations included in the forthcoming Westinghouse report and the need to modify the current Seabrook Station steam generator inspection program.

Seabrook Station's inspection plan is discussed in this response, therefore item (2) of the GL does not apply.

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

### **Response to GL Item 1:**

#### **Background**

As discussed in WCAP-15002, Rev. 1, surveys were sent by Westinghouse to all WOG utilities requesting the results of all steam generator, secondary side inspections and relevant tube inspections for tube support plate conditions. Completed surveys were received for 37 of 49 plants. For the Model D, E, 44E and F steam generators, responses were received for 12 plants. Of these, 11 responded as having inspected or reviewed inspection data for TSP ligament indications and 8 having performed SG secondary side entries; the data resulting in confidence of no wrapper drop. From the industry survey, no TSP ligament indications were found in steam generators with either carbon steel or stainless steel support plates.

The modes of degradation detected and reported by WOG utilities included; a) cases of flow-assisted corrosion, or erosion-corrosion, and b) premature cracking that resulted in either surface fatigue or corrosion cracking associated with surface conditions such as pitting or geometric concentrations. For the most part, however, the surveys did not report detection of several modes of degradation experienced in the EdF units. The Westinghouse group concluded: There was no evidence of post chemical clearing inspections discovering any significant material losses; there was no evidence of any dropped wrapper; and there was no evidence of progressive and continuing TSP ligament cracking or thinning. TSP ligament cracking or missing pieces of ligaments have been observed by WOG utilities, the evidence has been limited to units with carbon steel support plates with drilled round tube holes and flow holes. These TSP ligament conditions were generally traceable to initial inspections and did not progress based on sequential inspection data. The WCAP concluded many of the conditions are probably related to original TSP drilling alignment. There are cases of indications in TSPs that have been linked to patch plate welds.

The WCAP reported steam generators at WOG facilities that exhibit significant hour glassing of the TSPs, 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. Per Westinghouse, if denting remains 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 have generally remained 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 WOG plants with active denting are under periodic monitoring by the utility and have long-standing criteria and review by the NRC. Seabrook Station has not observed the hour glassing phenomena of the TSPs. In addition, per Westinghouse, the

**Response to USNRC Generic Letter 97-06  
"Degradation of Steam Generator Internals"**

EdF experiences reported are not related to support plate degradation that has progressed to the tube denting stage.

The secondary side internal degradation types found in Westinghouse steam generators as reported by the WOG are identified in Table 1.0.

**Response to USNRC Generic Letter 97-06  
"Degradation of Steam Generator Internals"**

**Table 1.0 Results from Westinghouse Owners Group on Steam Generators**

**Secondary Side Internal Degradation Types in Westinghouse Design SGs**

SG Category:	Feed Ring Carbon Steel TSPs	Preheat Carbon Steel TSPs	Feed Ring Stainless Steel TSPs <sup>(5)</sup>	Preheat Stainless Steel TSPs
<b>Degradation Type</b>				
<b>Erosion-Corrosion:</b>				
Moisture Separator	X	S	X	S
Water box	N/A	X <sup>(4)</sup>	N/A	S
TSP Flow	S	S	N/A	N/A
Hole/Ligaments				
Feed Ring/J-Tubes	X	N/A	X	N/A
<b>Cracking</b>				
TSP Ligaments <sup>(1), (2)</sup>	X	S	L	L
Wrapper Near Supports <sup>(2)</sup>	L	L	L	L
Transition Cone Girth Weld	X	L	X <sup>(3)</sup>	L
<b>Other</b>				
Wrapper Drop <sup>(2)</sup>	L	L	L	L

X = Observed in some steam generators

S = Susceptible

L = Low Susceptibility

N/A = Not Applicable

(1) Various indications of possible tube degradation may be artifacts of manufacturing anomalies related to patch paste plate welds and drilling alignment

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

(3) In SG replacements with the original shell and/or upper internals not replaced

(4) This Mechanism does not apply to the model D3 because of the Alloy 600 inlet manifold design used.

(5) Seabrook Station steam generator Model F is included in this category; refer to Table 2.0 for station specific inspection results.

## Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"

### Discussion of Inspection Results

The results of Seabrook Station steam generator inspections are summarized in Table 2.0 below. Additional information by refueling outage is also provided.

**Table 2.0**  
**WOG Internal Degradation Program SG Inspection Summary for Seabrook Station**

Component	Location			Condition			Type of Inspection
	Lower	Upper	Seam	Cracked	Missing	E/C	
Tube Support Plates	TSP 7			N	N	N	Visual (SID and video probe)
	TSP 6			N	N	N	Visual (SID)
	TSP 5			N	N	N	Visual (SID)
	TSP 4			N	N	N	Visual (SID)
	TSP 3			N	N	N	Visual (SID)
	TSP 2			N	N	N	Visual (SID)
	TSP 1			N	N	N	Visual (SID)
Wrapper	N/A	N/A	N/A	N/A	N/A	N	Visual (S/L installation)
Chemical Cleaning (not performed)	Shell	TSPs	Other	Pitting	Wastage	Crack	N/A
Other Secondary Side				Pitting	Wastage	Crack	
Girth Welds				N	N/A	N	UT/MT; includes Transition Cone
Feed Ring				N	N	N	Visual
J-Tube				N	N	N	Visual
Water Box				N/A	N/A	N/A	
Riser Barrels				NI	NI	NI	
Tangential Nozzle				NI	NI	NI	

Symbols: x = Found in steam generator  
 N = Inspected, no indications  
 N/A = not applicable to Seabrook  
 NI = not inspected at Seabrook

## Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"

SID = Support Plate Inspection Device  
E/C = Erosion/Corrosion  
S/L = Sludge Lance  
UT/MT = Ultrasonic Testing/Magnetic Particle Testing  
FOSAR = Foreign Object Search and Retrieval

### Outage Notes:

- OR01: FOSAR all generators; S/L all generators
- OR02: FOSAR all generators; S/L all generators
- OR03: FOSAR all generators; S/L all generators; SID inspection SG D; J-nozzle and feeding UT SG D; steam drum, moisture separators, support attachments, welds, and components S/G D.
- OR04: FOSAR all generators; S/L all generators, Pressure Pulse Clean all generators; J-nozzle to feeding inspection SG D.
- OR05: FOSAR all generators; S/L all generators; Pressure Pulse Clean all generators; SID inspection SG C and D; Feeding backing ring inspection SG D; Upper Steam Drum Inspection SG D

### Summary:

To date, no structural degradation in Seabrook Station steam generators has been identified. Visual inspections in the steam generators are used to evaluate the need for specialty cleaning applications, such as a Pressure Pulse Cleaning. North Atlantic is committed to performing secondary side visual inspections to assess the condition of the steam generators.

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

### **Safety Assessment**

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

- Loss of tube support leading to steam generator tube wear and possible primary-to-secondary leakage or inadequate burst margins.
- More significant tube support plate deformation during a postulated loss of coolant accident (LOCA) + significant seismic (SSE) event resulting in unacceptable steam generator tube support collapse or secondary-to-primary leakage.
- The generation of a loose object in the secondary side of a steam generator which may result in tube wear or impact and possibly primary-to-secondary leakage.

Based on the WOG review of Table 1.0, the only degradation types that may occur in the domestic WOG facilities that may result in a 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 inspection 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 have been observed, but only in units with carbon steel TSPs with drilled round holes and flow holes. According to the vendor, all utilities with Model D and E steam generators with carbon steel support plates inspect a significant percentage of steam generator tubes every outage with a bobbin probe, eddy current examination. At these facilities, 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 at these facilities will also consider the presence of any missing ligaments. The alternate plugging criteria would not be applied at these locations.

Per Westinghouse, it is expected that there is no increased susceptibility to ligament cracking near the wedge supports in the Model D, E, 44F and F (includes Seabrook Station) steam generator designs. Westinghouse concluded that 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

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

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, tube support plate flow holes, preheater water box erosion/corrosion 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 a single tube rupture event and, therefore, would remain within the current licensing bases of the plant.

It is North Atlantic's position that loose objects should be removed from the steam generator, whenever possible. Tubes observed to have visible damage should be eddy current inspected and plugged if found to be defective.

For the types of steam generator internal degradation anticipated at Seabrook Station, we expect steam generator internals degradation will be limited and 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. Eddy current inspection, foreign object search and retrieval (FOSAR) activities (during each refueling outage for selected SGs) and loose parts monitors should help to ensure the maintenance of tube integrity during subsequent plant operation.

### **In Service Test Plan**

Based on the above, the following inspection plan is implemented at Seabrook Station. Except where noted, these inspections will be completed each refueling outage. The majority of this program has been in place since OR03. Changes to the inspection program, scope and frequency, may occur based on the recommendations of the Westinghouse evaluation of Model F steam generators planned for completion in May 1998, as industry and site specific events or issues dictate, and as specific tooling becomes available for Model F steam generators.

#### General

North Atlantic performs the following secondary side visual inspections each refueling outage:

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

1. Visual inspection of the tube sheet annulus area to determine effectiveness of sludge lancing operations for all SGs.
2. FOSAR of the tubesheet annulus and blowdown lane following sludge lancing to check for foreign objects that could cause tube degradation for all SGs.
3. A support plate inspection in at least one steam generator each outage to assess the need for specialty cleaning such as Pressure Pulse Cleaning or chemical cleanings.
4. An upper steam drum inspection in at least one steam generator to assess the overall condition of the steam drum and feeding.

### Tube Support Plate Ligament Erosion/Corrosion and Cracking

This is considered a low susceptibility event since the tube support plates in the Model F steam generators at Seabrook Station are stainless steel. A number of industry-sponsored studies have reported that the chromium content in carbon steel has a significant effect on reduced resistance to an erosion/corrosion mechanism. The chromium content of stainless steel support plates is expected to preclude the occurrence of this degradation mechanism. Eddy current inspection is not applicable for the support plates with a quatrefoil broached hole design which includes Seabrook Station design.

As Seabrook Station has early Model F design steam generators, a sample inspection of the patch plate, plug weld regions, will be made. For all Model F designs, a sample inspection of the top support plate, tube lane region (where flow holes are provided instead of elongated slots) will be conducted. Flow holes are used to provide strengthening of the top tube support plate for U-bend support.

### Wrapper Drop

The frequency of sludge lancing at Seabrook Station is every refueling outage unless sludge trend data indicate the need for a different frequency. When sludge lance equipment can be inserted without interference, verification of no wrapper drop is assumed. If interference with the sludge lance equipment is detected, the lower wrapper support blocks will be visually inspected.

### Wrapper Cracking

No inspection is currently recommended by Westinghouse 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.

## **Response to USNRC Generic Letter 97-06 "Degradation of Steam Generator Internals"**

### Upper Package

Primary and Secondary moisture separators, feed ring (J-tube, carbon steel feed ring adjacent to J-tubes, T-section, reducer, backing ring and thermal sleeve) will be inspected on a periodic basis based on data available including loose parts monitoring information. The significance to tube integrity as a result of degradation of these components is primarily the impact of a loose part.

### Transition Cone Girth Weld

The weld will be inspected in accordance with the steam generator shell, ASME Section XI 1983 summer addenda in-service inspection requirements.

### Feedwater Nozzle

Degradation of the thermal sleeve may affect the feedwater nozzle. Loose parts monitoring is in service during power operation. Inservice inspection requirements for the feedwater nozzles have been completed in the past and are part of an ongoing program. Each outage a feedwater nozzle on one steam generator will be inspected for fatigue cracking.

### **Reference**

1. WCAP-1502, Rev. 1, "Evaluation of EdF Steam Generator Internals Degradation - Impact of Causal Factors on Westinghouse Series 51 Steam Generators"