North Atlantic

North Atlantic Energy Service Corporation
P.O. Box 300
Seabrook, NH 03874
(603) 474-9521

The Northeast Utilities System

August 14, 2001

Docket No. 50-443
NYN-01073
CR#99-07134-03

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

Seabrook Station
Steam Generators Inservice Inspection

North Atlantic Energy Service Corporation (North Atlantic) has enclosed pursuant to Seabrook Station Technical Specification Surveillance Requirement 4.4.5.5b, a report documenting the results of inservice inspections conducted on the Steam Generators during the seventh refueling outage which occurred in November 2000.

Should you have any questions regarding this matter, please contact Mr. James M. Peschel, Manager - Regulatory Programs, at (603) 773-7194.

Very truly yours,

NORTH ATLANTIC ENERGY SERVICE CORP.

Ted C. Feigenbaum
Executive Vice President and
Chief Nuclear Officer

cc: H. J. Miller, NRC Region I Administrator
G. F. Wunder, NRC Project Manager, Project Directorate I-2
G.T. Dentel, NRC Senior Resident Inspector

A047

ENCLOSURE 1 TO NYN-01073

NORTH ATLANTIC ENERGY SERVICE CORPORATION

SEABROOK STATION

STEAM GENERATORS B AND C INSERVICE INSPECTION

November, 2000

Prepared By: _____ 8/9/01
Russell Lieder, Engineering Supervisor — Date

Approved By: _____ 8/9/01
Robert White, Manager Mechanical Engineering — Date

Table of Contents

1.0 Introduction

In November 2000, Seabrook Station's seventh refueling outage, Steam Generators (S/Gs) B and C were inspected. This was accomplished in accordance with Seabrook Station Technical Specification 4.4.5. This report presents the results of the inspection pursuant to Technical Specification 4.4.5.5b and NEI 97-06 Revision 0.

The following results are presented:

- Scope of inspections performed
- Active degradation mechanisms found
- NDE techniques used for each degradation mechanism
- Number of tubes plugged or repaired during the inspection outage for each active damage mechanism
- Repair methods used and the number of tubes repaired by each repair method
- Total number and percentage of tubes plugged and/or repaired to date and the effective plugging percentage in each S/G
- Description of the tube integrity assessment
- Description of corrective actions implemented, if any
- Evaluation of circumstances if condition monitoring results exceeded the previous cycle of operational assessment.

Seabrook Station is a Westinghouse four loop pressurized water reactor with Model F steam generators. The steam generators are U-bend heat exchangers, with tube bundles fabricated using thermally treated Inconel 600 tubing. Each tube is identified by a row and column number. There are 59 rows and 122 columns in each steam generator, for a total of 5,626 tubes. Nominal tube outer diameter (OD) is 0.688" with a 0.040" nominal wall thickness.

The Technical Specifications require a tube to be plugged when tube wall loss equals or exceeds 40% of nominal wall thickness. There were 10 tubes that were required to be plugged as a result of eddy current inspection. There were also 6 tubes that did not exceed the plugging limit, but were preventively plugged as a conservative measure.

2.0 Scope of Inspections Performed

The inservice inspection of S/Gs B and C was conducted by Westinghouse Electric Corp. The data acquisition and analysis was conducted in accordance with the ASME Code, Seabrook Station Technical Specifications and procedures, Westinghouse procedures, EPRI Steam Generator Examination Guidelines, and the Seabrook Station Steam Generator Eddy Current Data Analysis Guidelines Manual. The acquisition and analysis techniques were qualified in accordance with Appendix H of the EPRI PWR Steam Generator Examination Guidelines.

The inspection was performed using both bobbin coil and motorized rotating probe techniques. The three-coil plus-point probe was used for the rotating probe technique, except in the low row U-bends, where a single plus-point mag-bias rotating probe was used. The three-coil plus-point probe consists of a plus point coil, a 115 mil pancake coil, and an 80 mil high frequency pancake coil.

The inspection plan for S/Gs B and C consisted of the following:

- 100% bobbin probe full length -- except for row 1 and 2 U-bends
- 50% row 1 and 2 U-bends with rotating mag-bias plus-point probe
- 50% top of the hot leg tubesheet , +/- 3", with three-coil plus-point probe
- 40% sample of HL combined population of straight section dings and dents >5 volts by bobbin using plus-point probe
- Plus-point examination of "I-code" indications that were new or not resolved after history review.

Additional visual inspection was performed to characterize the locations of the tubes exhibiting possible loose parts (PLP) signals during the inspection.

A visual inspection of installed tube plugs, both hot and cold legs, was performed utilizing remote video techniques.

3.0 Active Degradation Mechanisms

The only operational degradation mechanism observed was Anti-Vibration Bar (AVB) wear. Table 3 summarizes the ten largest new indications for S/Gs B and C.

The following table summarizes AVB indications for each S/G inspected with respect to the Reference 3 definition of an active degradation mechanism.

Criterion		S/G B	S/G C
1	Number of new indications ≥20% TWD (Through Wall Depth)	9	0
2	Number of indications with growth rates ≥20% TWD (Note 1)	0	3
3	Number new indication ≥40% TWD	1	0

Note 1. The Reference 3 criterion is growth rate ≥25% of the repair limit (40% TWD) or 10% in one cycle. Seabrook Station S/Gs B and C have operated 2 cycles since the last inspection; thus the controlling growth rate is adjusted to 20% TWD (2 x 10%/cycle).

A degradation mechanism is active:

- if the sum of the number of new indications that are greater than 20% TW (Through Wall, criterion 1) and the number of prior indications with growth rates greater than 25% of the repair limit per cycle (criterion 2) in that S/G is greater than, or equal to 10 indications, or

- if one, or more, new or previously reported indications display a growth rate equal to, or greater than, the repair limit (criterion 3).

Therefore, AVB wear is defined to be an active degradation mechanism in S/G B, since criterion 3 is met. AVB wear is not an active degradation mechanism in S/G C according to the definition provided in Reference 3.

4.0 NDE Techniques for Damage Mechanisms

Damage mechanisms associated to OR07 were grouped according to their likelihood of occurrence:

Active

Defined as a combination of 10 or more new indications of degradation (>20%TW) and previous indications of degradation which display an average growth rate equal to or greater than 25% of the repair limit per cycle in any one S/G. The following damage mechanisms and previous indications of degradation that display an average growth rate are considered active for OR07:

- Tube Wear @ AVB's EPRI ETSS #96004

Relevant

Defined as degradation found in similar plants with the same tubing material and similar design features, as well as mechanisms observed at Seabrook Station, which do not meet the active definition. Degradation relevant to Seabrook Station are:

- Loose Part Wear EPRI ETSS #96001 for Bobbin; # 96910 for RPC
- Baffle/ Support Plate Wear EPRI ETSS # 96001 and #96004 for bobbin; #96910 for RPC

Potential

Defined as degradation not found in similar plants but judged to have meaningful potential to occur based on historical or lab data. The following damage mechanisms are considered potential for OR07:

- U-Bend PWSCC EPRI ETSS #96511 for MR +PT and ETSS #99997 for Hi freq. +PT
- Ding SCC EPRI ETSS #96510 for RPC-ID and #96404 for RPC-OD
- Sludge Pile ODSCC EPRI ETSS #96007 for bobbin and #96404 for RPC
- ODSCC @ transition zone TSH EPRI ETSS # 96510 for RPC
- PWSCC @ transition zone TSH EPRI ETSS # 96404 for RPC
- Pitting in the presence of Copper EPRI ETSS #96005 for bobbin

5.0 Plugging

There were a total of 16 tubes plugged in S/Gs B and C. The following table gives the listing of the tubes and reason for plugging.

S/G	No. Plugged	Attribution	Comment
B	7	AVB Wear (3 of the 7 were administrative plugged at <40% TWD)	AVB Max TW Depth – 50% (see Table 2)
C	9	6 - AVB Wear, 1 of which was administratively plugged below 40% TWD; 1- Volumetric indication 1– Volumetric indication (administrative) 1 – Possible loose part (administrative)	AVB Max TW Depth – 57% (see Table 2) (SVI) R1C11, TSH+19.06; (VOL) R43C28, TSH+0.04 (PLP) R44C28, TSH+0.06

A number of the reported AVB wear indications exceeded the applicable Technical Specification plugging limit (40% throughwall depth (TWD)), requiring 9 tubes to be plugged, 4 in S/G B and 5 in S/G C. In addition, 3 tubes in S/G B and 1 tube in S/G C, with AVB wear, were conservatively, administratively plugged with maximum wear at the AVB of 37 to 39% TWD (see Table 2). Tube R30C70 in S/G B, which was found to have a small dent coincident with the AVB wear, was among the 3 tubes administratively removed from service.

The percentage of tubes plugged is very small as there are 5626 tubes in each of the four S/Gs and there are a total of 90 plugs installed. That equates to a plugging percentage of 0.4%.

There are 17 tubes plugged in S/G A; 22 tubes plugged in S/G B; 26 tubes plugged in S/G C; and 25 tubes plugged in S/G D.

6.0 Eddy Current Testing Results

The following table is a summary of the indications found during OR07. Among these indications, only the AVB indications represent a tube degradation mechanism. Disposition of other indications was performed in accordance with the guidelines of the Degradation Assessment. No tube corrosion degradation mechanisms were observed.

Summary of OR07 Inspection Results			
Indication/Signals	**Description**	**S/G B**	**S/G C**
BLG	Bulge	2	0
DNG	Freespan diameter reduction (>3V/ >5V) (3)	121/45	77/22
DNT	Diameter reduction at structures (>3V / >5V) (3)	670/389	316/135
MBM	Manufacturing Burnish Marks	87	24
PCT	AVB % Wear Indications (Bobbin Sizing)	157 (1)	225 (2)
PLP	Possible Loose Parts	21	5
PVN	Permeability Variation	0	0
SVI	Volumetric Indication - +Point	0	1
VOL	Volumetric Indications - +Point	0	1

(1) Includes 24 new indications and 12 tubes that previously had no reported indications
(2) Includes 35 new indications and 14 tubes that previously had no reported indications
(3) The OR07 reporting criterion for dings and dents was 3V.

The two bulge (BLG) indications were reported in S/G B (R13C99 at TSH+0.88" and R17C34 at TSH +0.91") from the bobbin probe. The bobbin voltages of these signals (14.6 volts and 13.7 volts, respectively) indicated that these bulges are very small. From a history review, both indications were determined to be present at the OR05 inspection in 1997; no change was observed in either indication since the prior inspection in 1997. Both indications were previously tested with the +Point probe during OR05 (1997), and no degradation was reported.

The 40% combined sample of dings (DNG) and dents (DNT) examined with the +Point probe confirmed the absence of degradation in the dings and dents.

The single volumetric indication (SVI) in tube R1C11 of S/G C at TSH+19.06" was reported from the +Point probe during the special interest inspection for bobbin indications without prior history. The bobbin voltage 0.47 volts indicated this was a very shallow indication. Depth estimates based on the bobbin phase analysis indicated that the depth was less than 20%TWD. The indication on the tube along the tube lane could have been caused by contact with an unknown object, possibly a foreign object or tooling for secondary side cleaning. The tube was plugged since no qualification for sizing was available.

A volumetric indication in S/G C (R43C28) was found at the top of the tubesheet. This indication was attributed to wear due to loose parts, since the position of this tube is near the periphery of the bundle which is consistent with locations commonly found to be affected by foreign objects. The adjacent tube (R44C28) was reported with a possible loose parts (PLP) signal. The depth of the wear was sized using the bobbin probe calibrated to the AVB wear standard and was found to be 11% TWD. Both R43C28 and R44C28 were administratively plugged.

Disposition of bobbin I-codes was accomplished either through +Point examination to confirm the absence of crack-like or other repairable degradation, or through a review of the history of the indications to verify that the signals had not changed from prior verification of absence of degradation.

Table 1 summarizes the 26 (21 in S/G B and 5 in S/G C) PLP indications that were reported. The tube columns adjacent to the indications in S/G B were visually examined utilizing the CECIL system. The only materials identified during the visual inspection were sludge and scale. Sludge and scale are indigenous to the S/Gs; evaluation of these materials has shown that sludge and scale are not significant relative to the potential for tube wear.

In S/G C, as noted above, tube R44C28, reported with a PLP signal, was administratively plugged because it was adjacent to the tube with the reported SVI indication and no confirmation of the presence or absence of a foreign object was available. Tube R43C26, near the periphery of the bundle where foreign objects are generally located, was previously reported with a PLP signal at OR05. No tube degradation was reported at either OR05 or OR07. Consequently, the PLP signal does not represent a potential for tube degradation and this tube was kept in service. The three other tubes with PLP signals are located in the interior of the bundle where foreign objects are not generally found. No degradation was associated with these PLP signals. Because of the location of these indications, the source of the signals is interpreted as sludge and scale (supported by the detailed visual inspections in S/G B) and does not represent a potential for tube damage. These tubes were retained in service.

7.0 Description of Tube Integrity Assessment

The indications found in the OR07 inspection satisfy the condition monitoring requirements of NEI 97-06 for structural and leakage integrity. No indications were found to exceed structural limits. These conclusions are based on the evaluations included in this report and summarized below:

1. AVB wear, classified as an "Active" degradation mechanism in the pre-outage degradation assessment, continues to be an active degradation mechanism in S/G B. The maximum observed indication (57% TWD) meets the structural requirements of draft Reg. Guide 1.121 (10) when the NDE uncertainty for AVB wear sizing, 4.3% at 95% CL, is added to the observed wear depths.

2. The incidence of wear at a depth of 57% TW after two cycles of operation is within the bounds of Model F S/G performance. The overall incidence of AVB wear at Seabrook Station S/Gs B and C is consistent with the Model F S/G operating experience.

3. A foreign object remaining in S/G B has not resulted in measurable wear on the adjacent tubes.

4. A single tube with a shallow volumetric indication was found at a location consistent with potential for loose parts wear. The tube adjacent to the tube with reported volumetric indication was reported with a potential loose parts signal. The depth of the indication was sized at approximately 11% TWD. Although neither of these tubes is a challenge to structural integrity, as a conservative measure, both of these tubes were plugged.

5. A shallow volumetric indication (SVI) was observed in tube R1C11 in S/G C at TSH+19.68". Since no accepted sizing technique was available for this indication, the tube was plugged. The shallow depth of the indication, estimated at <20%TW from bobbin, does not represent a challenge to tube integrity, based on comparison with the structural limit of 62% TW for uniform thinning of a tube.

6. No degradation indications were observed related to potential precursor signals such as dents and dings, or to interferences such as permeability variations, etc.

7. Neither pitting nor other corrosion related degradation mechanisms were observed.

AVB wear is the only operational degradation mechanism that has been observed at Seabrook Station. (Wear due to loose parts depends specifically on presence of objects, and not on operational conditions.) Based on conservative application of AVB wear growth rates, the condition of the Seabrook Station S/Gs tubes has been analyzed with respect to continued operability of the S/Gs until OR09 (the end of cycle 9) for S/Gs B and C, and until OR08 (the end of cycle 8) for S/Gs A and D. The analyses have shown that the structural integrity recommendations of draft Reg. Guide 1.121 are not exceeded. Conservative projection of the AVB wear to the end of cycle 9 indicates that structural criteria will continue to be satisfied until that time.

A loose part remaining in S/G B was analyzed for continued operation, Reference 3. The analysis demonstrated adequate margin to a very conservative assumed 40% TW wear limit for operation until, at least, OR09. Consequently, the structural integrity requirements are satisfied for the observed foreign object and the requirements for operation until, at least, OR09 are met.

Leakage requirements are satisfied since no leakage was detected at the plugs, and none of the AVB indications are projected to exceed the structural limit of 75% TW. No other indications with the potential for leakage were found.

8.0 REFERENCES

1. Seabrook Station Technical Specification 3/4.4.5.

2. NEI 97-06, December 1997, "Steam Generator Program Guidelines"

3. EPRI PWR Steam Generator Examination Guidelines, Revision 5.

4. Westinghouse Report SG-00-09-001, September 2000, "Steam Generator Degradation Assessment for Seabrook, OR07 Refueling Outage"

5. Westinghouse Report SG-00-12-002, November 2000, "Seabrook OR07 Condition Monitoring Assessment and Operational Assessment"

Table 1
Seabrook Station OR07 (2000) – Summary of PLP Indications

Row	Column	Volts	Deg	IND	Loc	In1	Probe	Cal	Location [1]	OR05 Result	Visual Results (CECIL)
Steam Generator B											
57	74	0.29	68	PLP	TSH	0.33	ZPS3C	17	Edge	NDD	No foreign material
57	73	0.26	74	PLP	TSH	0.21	ZPS3C	17	Edge	NDD	No foreign material
55	82	0.23	76	PLP	TSH	0.11	ZPS3C	25	Edge	NDD	No foreign material
47	28	0.26	64	PLP	TSH	0.17	ZPS3C	41	Edge	NDD	No foreign material
47	27	0.22	72	PLP	TSH	0.23	ZPS3C	43	Edge	NDD	No foreign material
46	99	0.21	74	PLP	TSH	0.28	ZPS3C	61	Edge	NDD	No foreign material
39	32	0.66	75	PLP	TSH	0.93	ZPS3C	125	Interior	PLP	No foreign material
39	16	0.52	75	PLP	TSC	4.29	ZPS3C	120	Edge	PLP	Sludge and Scale
38	16	0.68	76	PLP	TSC	4.30	ZPS3C	120	Edge	PLP	Sludge and Scale
38	25	0.48	80	PLP	TSC	0.21	ZPS3C	124	Interior	PLP	Sludge and Scale
37	25	0.66	74	PLP	TSC	0.32	ZPS3C	124	Interior	PLP	Sludge and Scale
34	57	0.52	71	PLP	TSH	0.21	ZPS3C	25	Interior	NDD	No foreign material
27	16	0.38	71	PLP	TSC	0.81	ZPS3C	120	Edge	PLP	Sludge "Rock"
27	15	0.70	69	PLP	TSC	0.96	ZPS3C	120	Edge	PLP	Sludge "Rock"
26	28	0.31	71	PLP	TSH	0.30	ZPS3C	35	Interior	PLP	No foreign material
25	28	0.43	74	PLP	TSH	0.27	ZPS3C	35	Interior	PLP	No foreign material
23	6	0.73	75	PLP	TSC	8.49	ZPS3C	120	Edge	Not available	No foreign material
22	6	0.66	72	PLP	TSC	8.35	ZPS3C	120	Edge	Not available	No foreign material
21	56	0.41	23	PLP	TSH	2.67	MBARH	105	Interior	Not available	No foreign material
14	42	0.43	76	PLP	TSH	0.23	ZPS3C	43	Interior	NDD	No foreign material
13	41	0.27	69	PLP	TSH	0.19	ZPS3C	41	Interior	NDD	No foreign material
Steam Generator C											
44	28	0.90	82	PLP [2]	TSH	0.06	ZPS3C	53	Edge		
43	26	0.59	85	PLP	TSH	0.09	ZPS3C	127	Edge	PLP	Not applicable
19	60	0.43	71	PLP	TSH	0.24	ZPS3C	65	Interior	Not available	Not available
13	71	0.87	186	PLP	TSH	2.09	MBARH	97	Interior	Not available	Not available
11	52	0.33	70	PLP	TSH	0.37	ZPS3C	61	Interior	Not available	Not available

Notes:
(1) Edge location is defined as ≤10 rows/columns from peripheral tube; Interior are >10 rows/columns from peripheral tubes
(2) Preventively plugged at OR07; see Section 3.2.

Table 2
AVB Wear Summary for Tubes Plugged

Tube	AVB1	AVB2	AVB3	AVB4	AVB5	AVB6
Steam Generator B						
R30/C51	-	40	-	-	38	-
R39/C53	22	37	48	45	50	-
R28/C55	-	40	-	-	31	-
R41/C74	17	40	37	48	41	17
R40/C38 (1)	-	28	27	32	39	22
R30/C70 (1)	-	-	-	-	37 (2)	-
R53/C87 (1)	-	-	17	39	37	27
Steam Generator C						
R39/C17	29	28	43	25	23	16
R48/C34	-	49	57	49	20	26
R47/C42	25	33	43	43	22	18
R49/C96	-	14	19	40	21	18
R41/C98	15	20	30	41	31	26
R51/C71 (1)	-	39	37	23	26	35

1) Administratively plugged
2) Coincident with a dent

Table 3 New Indications Summary (Top 10)			
Steam Generator B		**Steam Generator C**	
Tube	**Depth**	**Tube**	**Depth**
R28/C55 (1)	40 (2)	R37/C40	19
R30/C70 (1)	37 (2)	R47/C42 (1)	18
R36/C65	34	R40/C39	18
R33/C109	33	R39/C53	18
R28/C55 (1)	31	R38/C101 (1)	18
R17/C64 (1)	24	R30/C11 (1)	18
R30/C66	21	R53/C33	17
R18/C74 (1)	21	R51/C51	17
R27/C81	21	R47/C94 (1)	17
R46/C50	19	R43/C68 (1)	16

(1) Indication on a tube without other prior AVB indications
(2) Plugged at OR07