November 1, 2021

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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington DC 20555-0001

RE: St. Lucie Nuclear Plant, Unit 1
Docket No. 50-335
Refueling Outage SL1-30
Steam Generator Tube Inspection Report

Attached is the St. Lucie Unit 1 Technical Specification 6.9.1.12 steam generator tube inspection report for the spring 2021 refueling outage (SL1-30). This submittal is made within 180 days after the initial entry into hot shutdown following the completion of the steam generator inspection that was performed in accordance with TS 6.8.4.l, Steam Generator (SG) Program.

Please contact Tim Falkiewicz at 772-429-3756 should you have any questions regarding this submittal.

Sincerely,

Wyatt Godes
Licensing Manager
St. Lucie Nuclear Plant

WG/tf

Enclosure: SL1-30 Steam Generator Tube Inspection Report (7 Pages)

Enclosure

SL1-30 Steam Generator Tube Inspection Report

Introduction:

The enclosed Steam Generator Tube Inspection Report for St. Lucie Unit 1 is submitted for the inspection of the replacement steam generators (RSGs) during refueling outage 30 (hereafter referred to as the SL1-30 inspection/outage), as required by plant Technical Specification section 6.9.1.12. Per the St. Lucie Unit 1 Tech Spec section 6.8.4.l.d.2, the second sequential period is 108 EFPMs. The inspection during SL1-30, performed in accordance with Tech Spec section 6.8.4.l.d, was the 3rd inspection of the RSGs in the second sequential period, and the 7th ISI inspection since installation of the RSGs in 1997.

The plant Technical Specification requirement to inspect 100% of the tubes within the second sequential period has been completed. No primary-side inspection was performed during the SL1-28 or SL1-29 outages. Secondary-side activities were completed in SL1-28. At unit shutdown for the SL1-30 inspection, the RSGs had operated for approximately 20.5 EFPY (246.0 EFPM) since installation. This included operation for approximately 1.30, 1.30 and 1.38 EFPY during Cycles 27, 28 and 29, respectively. Initial entry into Hot Shutdown following completion of the SL1-30 inspection was made on May 5, 2021.

St. Lucie Unit 1 is a 2-loop Combustion Engineering designed NSSS with RSGs manufactured by B&W Canada. The RSGs have Alloy 690 thermally-treated tubes. Each RSG contains 8,523 U-tubes arranged in 141 rows and 167 columns. The tubes have a nominal OD of 0.75", a nominal wall thickness of 0.045", and have a triangular pitch arrangement. The tube bundle is supported by 7 horizontal lattice grid supports (LGS) along the straight lengths of tubes; the U-bend region is also supported by 10 fan bar supports (FBS) and 2 connector bar supports (CBS), all fabricated of stainless steel. The primary-side channel head has a stay cylinder as well as divider plates which provide flow separation between the inlet and outlet plenums. Tubes in rows 2 & 3 have the smallest U-bend radii. The general arrangement of the tube bundle supports including the FBS, CBS and horizontal LGS is shown in Appendix B. References to historical SG Tube Inspection Reports are provided in Appendix A along with acronyms and abbreviations used in this report.

A. Scope of Inspections Performed on each SG

The inspection scope during the SL1-30 outage met the current requirements of the St. Lucie Unit 1 Technical Specifications, SG Program Guidelines (NEI 97-06 Rev 3) and its referenced EPRI Guidelines. Since the St. Lucie plant has also submitted a License Amendment Request to adopt "Revised Frequencies for Steam Generator Tube Inspections (TSTF-577)"[1], the scope of inspections performed in SL1-30 was selected to also meet TSTF-577 inspection requirements.

Primary-side:

- 100% full-length bobbin probe exam of all active tubes.
- Array probe exam of peripheral tubes (high flow regions) in hot and cold legs (HL/CL) in each RSG, and low-row tubes (rows 1-4) along the tube free lane. (Peripheral tubes are defined as the 2 outermost tubes exposed to the annulus, all tubes in Rows 1-4 along the tube-free lane, and the innermost 2 tubes adjacent to the outermost edge of the stay cylinder.) The exam extent was from 01H to TTS-3".
- 100% of all ding (DNG) and dent (DNT) indications >5 Volts in the hotleg, U-bend and uppermost cold leg LGS locations with the +Point™ probe.

[1] Reference: "Enclosure 2 – Volume 16 – St. Lucie Plant, Units 1 and 2, Improved Technical Specifications Conversion ITS Chapter 5.0 Administrative Controls, Revision 0", NRC ADAMS Accession Number ML21265A301.

- Supplemental exam of a 50% tube sample of tight-radius U-bends of Rows 2 & 3 using the Array probe. The U-bend test extent was the portion of tubing between the uppermost horizontal LGS. During the 2nd sequential period, 100% of Rows 2 & 3 U-bends were examined using the +Point™ or array probes.
- +Point™ and/or array probe exams of all tubes with previously-identified possible loose part (PLP) indications, from TTS ± 3 inches.
- Diagnostic +Point™ examination at other special interest locations as required based on the results of the bobbin coil and array coil data.
- Visual inspection of all installed tube plugs in each RSG.
- Channel head bowl scan visual inspection of each RSG per recommended actions in Westinghouse NSAL 12-1 Rev 1"Steam Generator Channel Head Degradation" October 2017.

Secondary-side:

- Visual inspection of accessible components of the Steam Drum/Upper Internals was performed in both SGs. This included accessible portions of the primary separators and swirl vanes, and a sample of the secondary separators. At the TTS, visual exams were conducted of the annulus region, the no-tube lane and in-bundle columns during FOSAR after sludge lancing.

B. Active degradation mechanisms found

Wear at tube supports and historical PLP wear at the TTS were the active (existing) degradation mechanisms identified during the SL1-30 RSG inspection. Specifically, the degradation mechanisms were:

- Wear at fan bar supports (FBS)
- Wear at lattice grid supports (LGS)
- Historical PLP wear on 2 tubes at the HL TTS location

Wear at CBS locations was not found in SL1-30. No indication was identified that was due to a corrosion degradation mechanism. There was no new degradation from foreign objects.

C. Nondestructive examination techniques utilized for each degradation mechanism

Table 1 is a list of the EPRI Examination Technique Specification Sheets (ETSS) used for tube degradation detection and sizing, as needed, during the SL1-30 inspection.

Table 1

NDE Technique		Degradation Mechanism		ETSS
		Location/Description	Status	
1	Bobbin	Wear at FBS, CBS locations	Existing	96041.1 R6 / MAPOD I
2	Bobbin	Wear at LGS locations	Existing	96004.1 R13
3	Bobbin	Foreign Object Wear (PLP) (object not present)	Potential	27091.2 R2
4	+Point™	Wear at LGS Structures	Existing	96910.1 R11
5	+Point™	Wear at U-bend Supports	Existing	10908.5, R0
6	+Point™	Foreign Object / PLP Wear (morphology dependent)	Potential	27901.1 R1, 27902.1 R2, 27903.1 R1, 27904.1 R2, 27905.1 R2, 27906.1 R1, 27907.1 R2
7	Array	Foreign Object / PLP Wear	Potential	17901.1/.3 R0, 17902.1/.3 R0, 17903.1/.3 R0, 17904.1/.3 R0, 17905.1/.3 R0, 17906.1/.3 R0

D. Location, orientation (if linear), and measured sizes (if available) of service induced indications

Listings of all service-induced indications identified during the SL1-30 inspections are provided below in Tables 2a, 2b and 2c.

Table 2a: Wear at Lattice Grid Supports (LGS):

SG-A

ROW	COL	VOLTS	%TW	LOCATION
64	11	0.18	15	04C -1.69
107	138	0.09	10	02C -1.59
116	37	0.15	14	06H -1.03
139	74	0.13	12	03H -0.72

SG-B

ROW	COL	VOLTS	%TW	LOCATION
1	146	0.13	12	06C -1.57
2	127	0.13	12	05C +0.78
107	138	0.15	14	05H +1.52
133	60	0.12	12	02C -1.53
139	92	0.22	17	04H -1.54

Table 2b: Wear at Fan Bar Supports (FBS):

SG-A

ROW	COL	VOLTS	%TW	LOCATION
67	92	0.09	10	F09 -2.63
82	105	0.09	9	F06 +0.81
86	91	0.17	15	F06 +1.21
93	68	0.10	10	F06 +1.18
		0.11	11	F05 -1.25
97	74	0.14	13	F04 +1.09
101	74	0.21	16	F05 -1.21
		0.11	11	F04 -1.21
		0.17	15	F06 +1.26
		0.10	10	F07 +1.34
104	79	0.10	11	F06 -0.70
		0.13	12	F07 +1.33
124	91	0.10	11	F05 +0.94
125	68	0.21	17	F08 -1.30
		0.13	12	F07 -1.27
		0.12	12	F06 +1.15
		0.11	11	F05 -1.20
126	83	0.11	11	F08 +1.73
		0.15	14	F07 +1.21

SG-B

ROW	COL	VOLTS	%TW	LOCATION
93	90	0.18	15	F04 -1.35
99	142	0.11	11	F03 +1.01
102	67	0.16	14	F07 -1.24
104	91	0.11	11	F04 -1.30
108	87	0.13	12	F07 -1.10
114	101	0.16	14	F04 +1.24
118	129	0.09	10	F05 -1.79
121	90	0.13	12	F04 +1.17
		0.10	10	F06 +1.27
		0.12	12	F05 -1.12
		0.17	14	F03 +1.25
121	92	0.15	13	F07 +1.22
		0.19	15	F06 +1.21
123	94	0.23	17	F08 +1.28
124	97	0.12	12	F05 +1.07
127	62	0.14	13	F06 +1.11
		0.12	12	F05 -1.15
		0.09	10	F04 +0.00
129	74	0.10	11	F04 -0.61
		0.12	12	F02 -1.24
		0.11	11	F03 +1.20
		0.12	12	F04 -0.07
132	65	0.10	11	F07 -1.12
		0.12	12	F05 +1.09

Table 2c: Historical Wear due to PLP: SG-B

ROW	COL	VOLTS	%TW	LOCATION
137	78	0.25	18	TSH +0.40
139	78	0.15	14	TSH +0.52

Apart from the items in Table 2c, there were no new degradation from PLP/foreign objects. As mentioned previously, wear at CBS locations was not found in SL1-30. No indication was identified that was due to a corrosion degradation mechanism.

E. Number of tubes plugged during the inspection outage for each active degradation mechanism

The number of tubes plugged for each active degradation mechanism is summarized below in Table 3:

Table 3 - Tubes Plugged[1] during SL1-30 inspection outage

Degradation Mechanism[2]	SG 1A	SG 1B	Total
Wear at Fan Bar Supports (FBS)	5	5	10
Wear at Connector Bar Supports (CBS)	0	0	0
Wear at Lattice Grid Supports (LGS)	0	0	0
Wear due to PLP/foreign objects	0	0	0
Total	5	5	10

1. The tubes plugged in SG-1A were: R93C68, R101C74, R104C79, R125C68 and R126C83. The tubes plugged in SG-1B were: R121C90, R121C92, R127C62, R129C74 and R132C65.

2. No tube had wear which met the plugging criterion (≥ 40%TWD) in Technical Specifications. The tubes plugged were preventively taken out of service to support the operational assessment until the next primary-side inspection.

F. Total number and percentage of tubes plugged to date

The total number and percentage of tubes plugged to-date in each SG is summarized below in Table 4:

Table 4 - Cumulative Tube Plugging Summary following the SL1-30 Inspection

SG	Total Plugged	% Plugged
1A	106	1.24%
1B	59	0.69%

G. The results of condition monitoring, including the results of the tube pulls and in-situ testing

All SG tubes inspected during the SL1-30 outage met the condition monitoring (CM) requirements for structural and leakage integrity. No evidence of corrosion degradation was detected. No primary-to-secondary leakage was noted since the last inspection. No indications were found to exceed the structural limits.

1. The largest wear indications at lattice grid support (LGS) locations in each SG were 15%TWD and 17%TWD, in SG-1A and SG-1B, respectively. All detected LGS wear indications fell below the CM limit for burst and leakage. No tube was plugged due to wear at a LGS location. The list of LGS Wear indications in SL1-30 is provided in Table 2a.

2. The largest wear indication at fan bar support (FBS) locations in each SG was 17%TWD. All detected FBS wear indications fell below the CM limit for burst and leakage. Five (5) tubes in SG-1A and 5 in SG-1B were preventively plugged due to wear at FBS locations to support the operational assessment to the next inspection. The list of FBS Wear indications in SL1-30 is provided in Table 2b.
3. No wear indications were found at U-bend connector bar support (CBS) locations. Two (2) historical PLP wear indications at the TTS in SG 1B measured 14% and 18% in SL1-30 using the +Point™ probe. There has been no growth in these 2 PLP wear indications since they were first reported. The list of historical PLP wear indications is provided in Table 2c.
4. The upper steam drum components examined in each SG include accessible primary moisture separators, a sample of secondary moisture separators, the lower deck drains, the upper bundle region and the main steam outlet nozzle. No signs of damage, degradation, erosion or corrosion were observed. A camera was lowered to view portions of the feedring and J-nozzles which are normally inaccessible. Some discoloration/scouring was noted on the outer surface of the bundle wrapper in SG-1B where feedwater discharges (overspray) from the J-tubes. The condition was reviewed and entered into the corrective action program for future monitoring by the SG Program.
5. No degradation was found during the visual inspection of the primary-side channel head bowl. No corrosion-related degradation was identified anywhere in the channel head of the SGs. All previously-installed tube plugs were confirmed to be in their correct locations, and showed no visible signs of leakage based on the visual examination. No degradation of the tube plugs was identified.
6. Sludge lancing the TTS after upper bundle flush (UBF) removed 28 and 29 lbs. of sludge from SG-1A and SG-1B, respectively. During secondary-side visual exams (FOSAR) at the TTS, two (2) foreign objects (FOs) were identified in SG-1A and removed from the SG. One appeared to be a piece of flexitallic gasket material and was found among peripheral tubes in the hotleg; the other was a metallic wire and was found in the annulus on the cold leg. In SG-1B, one FO was identified and removed from the SG. It appears to be a piece of weld slag and was found close to the no-tube lane in the cold leg.

In summary, all wear indications detected in SL1-30 met CM requirements. As a result, no tubes required in-situ pressure testing for burst or leakage, and no tube pulls were required. Therefore, all tubes met the structural and leakage integrity requirements of the St. Lucie Unit 1 Tech Specs.

H. The effective plugging percentage for all plugging in each SG

No tube repair methods (such as sleeving) are approved for St. Lucie Unit 1 that would have an effect on the effective plugging percentages. Therefore, the applicable effective plugging percentage is synonymous with the “% Plugged” entries shown in “Item F” above.

APPENDIX A - Additional Information

References to historical SG Tube Inspection Reports

SG ISI #	EOC	Outage	NRC ADAMS Accession No.
1	EOC-15	SL1-16	ML003684169
2	EOC-16	SL1-17	ML012390098
3	EOC-18	SL1-19	ML053190206
4	EOC-21	SL1-22	ML091120207
5	EOC-24	SL1-25	ML14127A008
6	EOC-26	SL1-27	ML17117A334

Abbreviations and Acronyms

CBS	Connector Bar Support
CL	Cold Leg
CM	Condition Monitoring
DNG/DNT	Dings/Dents
EOC-29	End-of-cycle 29 (or SL1-30 inspection)
EFPM	Effective Full Power Months
EFPY	Effective Full Power Years
EPRI	Electric Power Research Institute
ETSS	Examination Technique Specification Sheet
FBS	Fan Bar Support
FO	Foreign Object
FOSAR	Foreign object search and retrieval
HL	Hot Leg
ISI	In-service Inspection
LGS	Lattice Grid Support
NSSS	Nuclear Steam Supply System
OD	Outside Diameter
PLP	Possible Loose Part
RSG	Replacement Steam Generator
SG	Steam Generator
TSH	Tubesheet Hot
TTS	Top of Tubesheet
TWD	Through Wall Depth
UBF	Upper bundle flush

APPENDIX B - General arrangement of St. Lucie Unit 1 RSG Tube Bundle Supports

Note: Seven horizontal lattice grid support (LGS) elevations are labeled sequentially from bottom to top as 01H to 07H (or 01C to 07C) according to the following table. There is no baffle plate.

	Horizontal LGS designation						
Tube Support	1	2	3	4	5	6	7
Hot Leg	01H	02H	03H	04H	05H	06H	07H
Cold Leg	01C	02C	03C	04C	05C	06C	07C