Mark J. Ajluni, P.E.
Nuclear Licensing Director

Southern Nuclear Operating Company, Inc.
40 Inverness Center Parkway
Post Office Box 1295
Birmingham, Alabama 35201

Tel 205.992.7673
Fax 205.992.7885

SOUTHERN COMPANY

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U. S. Nuclear Regulatory Commission
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Vogtle Electric Generating Plant – Unit 1
Sixteenth Maintenance/Refueling Outage
Steam Generator Tube Inspection Report

Ladies and Gentlemen:

In accordance with the requirements of Vogtle Electric Generating Plant Technical Specification 5.6.10, Southern Nuclear Operating Company submits this report of the steam generator tube inspections performed during the Unit 1 sixteenth maintenance/refueling outage (1R16). Entry into Mode 4 occurred on March 29, 2011.

This letter contains no NRC commitments. If you have any questions, please contact Jack Stringfellow at (205) 992-7037.

Respectfully submitted,

Mark J Ajluni

M. J. Ajluni
Nuclear Licensing Director

MJA/RMJ/lac

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cc: Southern Nuclear Operating Company
Mr. S. E. Kuczynski, Chairman, President & CEO
Mr. J. T. Gasser, Executive Vice President
Mr. T. E. Tynan, Vice President – Vogtle
Ms. P. M. Marino, Vice President – Engineering
RType: CVC7000

U. S. Nuclear Regulatory Commission
Mr. V. M. McCree, Regional Administrator
Mr. P. G. Boyle, NRR Project Manager - Vogtle
Mr. L. M. Cain, Senior Resident Inspector – Vogtle

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Introduction

The 1R16 outage was conducted after cumulative service equivalent to ~21.2 EFPY (effective full power years); the Cycle 16 power generation was ~1.4 EFPY. Analyses, based on conservative assumptions used in the Condition Monitoring and Operational Assessments, demonstrated that there were no tubes that exceeded the Reg. Guide 1.121 or NEI-97-06 Revision 2 criteria for tube integrity during Cycle 16. The eddy current inspections were performed by the Steam Generator Maintenance Services Group of the Westinghouse Nuclear Services Division. Secondary data analysis was performed by NDE Technology under direct contract with Southern Nuclear. One tube (R26 C110) in Steam Generator 1 (SG1) was plugged due to loose part wear that exceeded the Technical Specifications (TS) plugging criteria. One tube (R8 C57) was plugged in SG4 due to an outer diameter (OD) axial crack signal below the bottom of the tube expansion transition. Criteria for in-situ testing were not met for either tube. The H* Alternate Repair Criteria was approved by the NRC for implementation during 1R16 (ML110660264). Therefore, tube end +Point inspections below top of tubesheet (TTS) -15.2 inches were omitted, and the TTS inspections ranged from TTS +3 inches to TTS -15.2 inches.

1R16 Scope

The scope for 1R16 involved the scheduled inspections listed below. The inspection program, required by Revision 7 of the EPRI PWR SG Examination Guidelines, addressed the known degradation mechanisms observed in Vogtle Unit 1 in prior inspections, as well as those regarded as potential degradation mechanisms.

- 100% Bobbin examination of tubes in SGs 1 and 4, except for Rows 1 and 2, which are inspected from tube end to tube support plate (TSP) #7 from both hot leg (HL) and cold leg (CL).
- 100% +Point examination of Row 1 and Row 2 U-bends from the top TSP on the HL to the top TSP on the CL in all SGs.
- +Point examination of Special Interest, HL and CL, of bobbin possible flaw locations including U-bends.
- 100% +Point examination at HL tubes in all SGs from the top of tubesheet (TTS) to the licensed Temporary Alternative Repair Criteria (TARC) depth for H* (tubesheet region on HL side (TSH) +3/-15.2 inches). This inspection captured 100% of the TTS and BLG/ OXP populations, as defined below, along with the required periodic sample specified in the regulatory approval of TARC.
  - BLG = differential mix diameter discontinuity signal within the tubesheet of 18 volts or greater as measured by bobbin coil probe;
  - OXP = a tube diameter deviation within the tubesheet of 1.5 mils or greater as measured by bobbin coil profile analysis.
- 25% +Point examination of SG1 and SG4 CL tubes TTS +3 inches to -3 inches. This inspection was aimed at early warning awareness of TTS degradation mechanisms and was analogous to a similar inspection that was performed in SG2 and SG3 during 1R15.
- +Point examination of 25% of dents and dings ≥ 2 volts in HL straight lengths and U-bends of all SGs.
- Visual inspection of tube plugs in all 4 SGs.

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Damage Mechanisms Found and NDE Techniques Utilized

All of the damage mechanisms found during 1R16 inspections were identified in previous inspections and in the 1R16 SG Degradation Assessment.

- Mechanical Wear due to a foreign object was found in all SGs. +Point and bobbin techniques were used to evaluate the wear.
- Mechanical Wear at anti-vibration bars (AVBs) were found in SGs 1 & 4. Bobbin technique was used to evaluate the wear.
- A single axial outer diameter stress corrosion cracking (ODSCC) indication was found in SG4. +Point probe techniques were used to analyze the indication.

Service Induced Indication Descriptions

Foreign Object Wear

- The foreign object wear (PCT) identified in SG1 R26 C110 is a new indication located at the TSP 2H-0.23 inch. The tube was plugged based on the 40% through wall (%TW) Technical Specification plugging limit. The +Point % TW depth did not exceed the threshold for proof testing and the bobbin voltage did not exceed the threshold for leak testing; therefore, in-situ testing was not required to demonstrate tube integrity. The loose part could not be verified visually; however, a boundary, 2 tubes deep, was inspected around R26 C110 using +Point testing. There was no evidence of wear on the boundary tubes and no possible loose part (PLP) indications.
- PCT indications near the TTS in SG1 Rows 39 and 41 from Columns 100 to 103 were reported in previous outages. The indications exhibited almost zero growth in 1R16 and remain in service.
- The legacy indication at R30 C111 was examined using +Point techniques and remained unchanged.
- One volumetric indication was found just above TTS on the CL. +Point testing determined there is a 27% TW wear indication. Bobbin data from 1R14 and 1R16 was analyzed. It was concluded the bobbin probe signal was obscured in the expansion transition, and the flaw may have existed at the 1R14 inspection.

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Table 1: Vogtle 1 PLP/PCT for 1R16

SG	Row	Col	Volts	Ind	%TWD[7]	Locn
1	14	112	0.38	PLP[5]	-	TSH[1]
1	15	112	0.27	PLP	-	TSH
1	25	8	0.15	PLP	-	TSH
1	25	9	0.15	PLP	-	TSH
1	26	110	0.66	PCT[6]	42	2H[2]
1	36	87	0.47	PLP	-	TSH
1	36	88	0.51	PLP	-	TSH
1	39	100	0.13	PCT	14	TSH
1	41	97	0.32	PCT	27	TSC[3]
1	41	100	0.17	PCT	17	TSH
1	41	100	0.46	PCT	34	TSH
1	41	101	0.29	PCT	25	TSH
1	41	102	0.22	PCT	21	TSH
1	41	103	0.25	PCT	23	TSH
2	18	8	0.09	PLP	-	TSH
2	19	8	0.08	PLP	-	TSH
2	35	106	0.15	PLP	-	TSH
2	36	106	0.13	PLP	-	TSH
3	23	97	0.31	PLP	-	TSH
3	30	111	1.74	PCT	29	BPH[4]
4	30	18	0.25	PLP	-	TSH
4	30	18	0.08	PLP	-	TSH
4	31	18	0.4	PLP	-	TSH
4	31	18	0.48	PLP	-	TSH
4	38	104	0.13	PCT	12	BPH

[1] TSH – Tubesheet region on HL side.
[2] 2H – Tube Support Plate 2 on HL side
[3] TSC – Tubesheet region on CL side
[4] BPH – Flow distribution baffle plate (FDB) on HL side
[5] PLP – Possible Loose Part
[6] PCT – Foreign Object Wear
[7] %TWD – Percent Through-wall Depth

AVB Wear

AVB wear continued to be identified in Vogtle 1R16 in SG1 and SG4. AVB wear identified is provided in the following tables.

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Table 2: Vogtle 1R16: SG1 AVB Wear Indications

Row	Col	Location[1]	1R16 % TW		Row	Col	Location[1]	1R16% TW
23	40	AV6	11		42	43	AV5	14
23	116	AV6	10		42	43	AV3	12
24	116	AV6	13		42	43	AV2	11
26	116	AV6	19		43	21	AV5	27
26	116	AV1	12		43	21	AV4	22
27	100	AV5	11		43	21	AV6	12
27	115	AV6	15		43	21	AV2	10
27	115	AV1	14		43	81	AV4	13
28	115	AV6	32		43	81	AV5	8
28	115	AV1	17		43	82	AV3	14
32	104	AV6	14		43	83	AV4	20
34	107	AV3	16		43	83	AV2	15
34	107	AV1	12		43	83	AV5	12
35	16	AV4	13		43	83	AV1	11
35	18	AV6	11		43	83	AV3	9
35	34	AV4	11		43	85	AV2	10
35	34	AV3	10		43	91	AV2	30
35	104	AV3	14		43	91	AV3	18
35	104	AV4	13		43	91	AV4	14
36	105	AV3	11		44	21	AV5	15
37	77	AV3	11		44	80	AV4	11
37	102	AV5	21		44	80	AV5	10
38	16	AV4	32		44	80	AV3	9
38	16	AV2	16		44	102	AV2	13
38	16	AV3	15		45	30	AV3	14
38	16	AV5	11		45	90	AV2	14
38	108	AV1	12		45	90	AV3	10
38	108	AV6	12		46	41	AV1	10
39	48	AV3	21		47	99	AV2	13
39	48	AV4	21		48	97	AV1	14
39	48	AV5	14		49	88	AV4	9
39	48	AV2	12		50	29	AV2	11
39	87	AV4	11		50	29	AV1	10
39	90	AV3	11		52	33	AV2	17
39	90	AV2	10		52	33	AV3	17
39	104	AV4	12		52	39	AV3	27
40	20	AV4	10		52	39	AV4	27
40	34	AV4	16		52	39	AV2	21
40	34	AV3	10		52	39	AV5	12

[1] AV# - Location of AVB intersection with the tube (there are up to 6)

Table 2: Vogtle 1R16: SG1 AVB Wear Indications (continued)

Row	Col	Location[1]	1R16 %TW		Row	Col	Location[1]	1R16 %TW
40	34	AV6	9		52	44	AV4	21
40	34	AV2	8		52	91	AV1	14
40	47	AV4	34		53	39	AV6	11
40	47	AV3	32		53	43	AV2	10
40	47	AV6	12		53	43	AV5	9
40	47	AV5	10		53	87	AV3	10
40	62	AV3	13		53	90	AV6	16
40	62	AV5	10		54	36	AV2	11
40	75	AV3	12		54	37	AV1	12
40	94	AV4	10		54	37	AV6	12
40	104	AV3	16		54	45	AV2	10
40	104	AV4	15		54	53	AV2	10
41	18	AV6	14		54	83	AV1	11
41	18	AV4	11		54	83	AV6	11
41	18	AV5	10		57	45	AV3	35
41	23	AV4	10		57	45	AV2	22
41	34	AV4	10		57	45	AV6	15
41	44	AV3	34		57	45	AV5	13
41	44	AV2	19		57	78	AV6	15
41	51	AV4	12		58	75	AV1	12
41	80	AV3	12		58	76	AV6	11
42	34	AV4	13		59	62	AV6	12
42	37	AV6	12					
42	43	AV4	14					

[1] AV# - Location of AVB intersection with the tube (there are up to 6)

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Table 3: Vogtle 1R16: SG4 AVB Wear Indications

Row	Col	Location[1]	1R16 %TW		Row	Col	Location[1]	1R16 %TW
27	8	AV6	14		40	84	AV5	10
27	9	AV5	17		40	86	AV4	12
27	43	AV5	9		40	87	AV4	17
27	51	AV2	10		40	87	AV5	21
28	40	AV5	19		40	88	AV3	15
28	65	AV5	10		40	88	AV4	22
28	82	AV5	12		40	88	AV5	17
30	9	AV2	18		40	88	AV6	15
30	9	AV5	34		40	90	AV3	10
30	20	AV2	9		40	90	AV4	16
30	40	AV5	15		40	90	AV5	10
30	40	AV6	10		40	92	AV3	12
30	113	AV5	10		40	92	AV5	15
30	114	AV5	26		40	93	AV2	12
32	106	AV3	12		40	93	AV5	12
32	110	AV3	12		40	95	AV2	12
32	111	AV1	9		40	95	AV3	12
32	111	AV3	13		40	95	AV4	25
32	111	AV4	9		40	95	AV5	12
33	12	AV2	11		40	100	AV2	14
33	12	AV3	10		40	100	AV3	10
33	12	AV4	10		40	100	AV4	13
33	12	AV6	10		40	100	AV5	12
33	34	AV3	11		40	100	AV6	13
33	34	AV4	9		40	105	AV2	8
33	34	AV5	10		40	105	AV4	17
33	91	AV2	7		40	105	AV5	18
33	108	AV3	13		40	106	AV3	14
33	110	AV3	22		40	106	AV4	20
33	110	AV5	11		40	106	AV5	23
33	110	AV6	8		41	23	AV2	7
33	111	AV3	17		41	97	AV5	13
33	111	AV4	19		41	105	AV3	9
33	111	AV6	18		42	20	AV6	11
34	15	AV5	10		42	100	AV2	20
36	13	AV1	10		42	100	AV3	16
36	13	AV2	9		42	100	AV4	20
36	14	AV1	10		42	100	AV6	12
36	39	AV3	19		42	101	AV3	16
36	79	AV4	16		42	101	AV4	21
36	104	AV2	15		42	101	AV5	23
36	104	AV3	9		42	104	AV3	17
36	104	AV5	10		42	104	AV4	14
36	105	AV2	8		43	46	AV6	19
36	105	AV5	11		43	66	AV2	13
36	106	AV5	8		43	66	AV3	12
36	106	AV6	11		43	92	AV3	15
36	107	AV3	10		43	93	AV4	11

[1] AV# - Location of AVB intersection with the tube (there are up to 6)

Table 3: Vogtle 1R16: SG4 AVB Wear Indications (continued)

Row	Col	Location[1]	1R16 %TW		Row	Col	Location[1]	1R16 %TW
36	109	AV3	11		43	101	AV4	18
37	80	AV4	10		43	101	AV5	29
38	19	AV5	10		44	91	AV5	13
38	35	AV2	10		44	96	AV2	10
38	52	AV3	7		44	96	AV3	30
38	52	AV4	10		44	96	AV4	27
38	55	AV4	10		44	96	AV6	16
38	74	AV2	8		44	97	AV2	20
38	76	AV3	12		44	97	AV4	22
38	76	AV4	13		44	97	AV5	26
38	76	AV6	9		44	99	AV6	9
38	86	AV4	16		45	22	AV5	9
38	96	AV2	14		45	101	AV1	10
38	96	AV4	10		45	101	AV5	10
38	96	AV5	11		45	101	AV5	7
38	103	AV4	11		48	97	AV6	10
38	104	AV3	10		49	54	AV2	17
38	104	AV4	14		49	54	AV3	32
38	104	AV5	13		49	54	AV4	29
38	108	AV4	14		49	54	AV5	22
39	51	AV4	10		49	95	AV3	10
39	51	AV5	10		50	63	AV2	16
39	51	AV6	12		50	63	AV3	22
39	56	AV2	11		50	63	AV4	18
39	56	AV3	17		50	76	AV3	13
39	56	AV4	14		50	76	AV4	13
39	58	AV2	11		50	76	AV5	27
39	58	AV4	18		53	89	AV4	15
39	58	AV6	11		53	90	AV1	10
39	75	AV5	15		53	90	AV5	12
39	107	AV3	10		53	90	AV6	12
40	24	AV5	15		54	36	AV5	13
40	25	AV3	10		54	38	AV1	10
40	29	AV2	11		54	38	AV5	11
40	39	AV3	13		54	38	AV6	10
40	56	AV3	15		55	40	AV6	12
40	62	AV2	26		55	82	AV5	12
40	62	AV3	33		56	41	AV5	11
40	62	AV4	26		56	81	AV6	11
40	62	AV5	13		57	55	AV6	10
40	78	AV2	18		58	48	AV5	10
40	78	AV3	17		58	65	AV1	11
40	82	AV2	13		58	73	AV6	13
40	82	AV3	23		59	57	AV5	14
40	82	AV4	33		59	59	AV2	13
40	82	AV5	18					
40	84	AV2	14					

[1] AV# - Location of AVB intersection with the tube (there are up to 6)

ODSCC

A single axial ODSCC indication was found in SG4 R8 C57. It is located below the bottom of the expansion transition at TSH-0.19. It is entirely within the tubesheet. Criteria for in situ proof testing and leak testing were not met; therefore, in-situ testing was not required to be performed to demonstrate tube integrity. The tube was plugged based on detection of axial ODSCC.

Table 4: Vogtle 1 Axial ODSCC for 1R16

SG	Row	Col	Volts	Ind	Max. Depth (%)	Axial Length (inches)
4	8	57	0.21	SAI[1]	54.2	0.13

[1]SAI – Single axial indication

Slippage Monitoring

Bobbin data from SG1 and SG4 was screened for tubesheet indications of greater than 50 volts with a phase angle between 25 and 50 degrees, indicative of a severed tube. No tube severance indications were found. There was no leakage present during Cycle 16. Therefore, the performance criteria for Cycle 16 with respect to the H* Temporary Alternate Repair Criteria (TARC) have been satisfied.

Number of Tubes Plugged

Table 5 presents a summary list of all SG tubes plugged in 1R16 and the related degradation mechanism.

Table 5: 1R16 Plugged Tubes (2)

SG	Row	Col	Ind	Degradation Mechanism
1	26	110	PCT	Foreign Object Wear
4	8	57	SAI	ODSCC

Total plugging in the SGs after 1R16 is as follows:

SG 1 – 28 tubes for a total of 0.50% tubes plugged
SG 2 – 19 tubes for a total of 0.34% tubes plugged
SG 3 – 33 tubes for a total of 0.59% tubes plugged
SG 4 – 68 tubes for a total of 1.21% tubes plugged

Condition Monitoring Conclusions

No indications, including +Point testing of I-code indications and completion of the scheduled +Point programs for the tubesheet H* region, the top of the tubesheet, the BLG/OXP population, DNG/DNT locations, and small radius U-bends, were found to exceed the condition monitoring limits specified in the Degradation Assessment. No tubes required in-situ pressure testing to demonstrate tube integrity.

None of the AVB wear indications in either SG1 or SG4 exceed the Condition Monitoring limits as given in the 1R16 Degradation Assessment.

As stated above, one tube in SG1 was identified by eddy current testing to have an indication associated with foreign object wear. No additional secondary side tube damage attributable to loose parts/foreign objects was identified from the foreign object search and retrieval (FOSAR) and visual inspections.

Given the absence of operating leakage during Cycle 16, it is concluded that there was no leakage from plugs. This is consistent with the video inspection of the tube plugs in all 4 SGs which produced no exceptions to expected conditions.

Evaluation of the indications found in the 1R16 inspections confirms that the tube integrity structural and leakage performance criteria condition monitoring requirements specified in Reg. Guide 1.121 and NEI-97-06 Revision 2 are satisfied.