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OPPD
Omaha Public Power District

444 South 16th Street Mall
Omaha NE 68102-2247

March 26, 2004
LIC-04-0040

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Reference: Docket No. 50-285

SUBJECT: Fort Calhoun Station (FCS) Steam Generator Eddy Current Test Report - 2003 Refueling Outage

Pursuant to FCS Unit No. 1 Technical Specification 3.17(5)(ii), Omaha Public Power District (OPPD) submits the attached FCS Steam Generator Eddy Current Test Report which summarizes testing performed during the Fall 2003 Refueling Outage.

If you have any questions or require additional information, please contact Dr. R. L. Jaworski at (402) 533-6833. No commitments are made to the NRC in this letter.

Sincerely,

R. L. Phelps
Division Manager
Nuclear Engineering

RLP/JKM/rrl

Attachment: Fort Calhoun Station Steam Generator Eddy Current Test Report, 2003 Refueling Outage

c: B. S. Mallett, NRC Regional Administrator, Region IV
A. B. Wang, NRC Project Manager
J. G. Kramer, NRC Senior Resident Inspector

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ATTACHMENT

FORT CALHOUN STATION

STEAM GENERATOR EDDY CURRENT TEST REPORT

2003 REFUELING OUTAGE

FORT CALHOUN STATION
STEAM GENERATOR EDDY CURRENT TEST REPORT
2003 REFUELING OUTAGE

INTRODUCTION

This report summarizes steam generator eddy current test results obtained during the Fort Calhoun Station (FCS) 2003 Refueling Outage (RFO). Omaha Public Power District (OPPD) submitted summaries of results of the previous eddy current inspection to the NRC in the following documents:

1. Fort Calhoun Station (FCS) Steam Generator Eddy Current Test Report - 2002 Refueling Outage, dated December 3, 2002 (LIC-02-0139)

2. Fort Calhoun Station Steam Generator Report (TAC No. MB6954) Response to Request for Additional Information, dated July 30, 2003 (LIC-03-0100)

Description of FCS Steam Generators

The Fort Calhoun Station is a two-loop Combustion Engineering design Nuclear Steam Supply System (NSSS). Each steam generator contains 5005 vertical tubes fabricated from Alloy 600 material. The tubes are nominally 0.750 inch outside diameter with a nominal tube wall thickness of 0.048 inches, and are installed in the tubesheet in a 1-inch pitch, triangular array. The tube to tubesheet joints are full tubesheet depth explosively expanded and are seal welded at the primary face of the tubesheet. The operating temperature (T_{hot}) is 593°F.

All tube supports in the FCS steam generators are carbon steel material. With the exception of the upper most support, all supports of the vertical tube run are of the eggcrate lattice type with drilled tube hole Drilled Support Plates at the 90 degree and 270 degree orientations. The upper most support at elevation 8 is a partial plate with drilled tube holes. Tube holes in drilled supports are 0.765-inch diameter (nominal) providing a nominal annular clearance around the tubes of 0.0075 inch. Drilled plate support segments include 0.25 inch drilled flow holes nominally in the center of each triangular array of three tubes. Of the 5005 tubes in each steam generator, 975 tubes pass through one or more one-inch thick drilled plate supports. The remainder is supported totally by eggcrate lattice support structures. The eggcrate structures are fabricated from interlocking 0.090-inch thick strips of alternating 2 inch and 1 inch widths. The eggcrate supports provide a robust structure, while at the same time providing an open configuration with minimum flow resistance. Freedom of flow through the area adjacent to the tube increases the flushing capability to reduce potential for deposit loading.

The horizontal sections of the double 90-degree U-bends are supported by three vertical strips welded to diagonal strips, which pass nominally through the center of the 90-degree bends. The vertical and diagonal strip subassemblies serve as spacers between each line of tubes. The vertical and diagonal strips are 0.090 inch thick and 4 inches wide. The vertical strips are connected to three horizontal,

structural I-beams, which in turn are connected to the tube bundle shroud. Additionally, 1-inch thick horizontal scalloped bars pass between each row of tubes and interlock with the vertical strips to provide a rigid structure designed to resist postulated accident induced loads.

The FCS steam generators have operated for 30 years and accumulated 22.33 EFPY by the 03RFO outage. Before the 2003 Outage, 533 tubes had been plugged which is less than 5.4 % of the total number of original tubes.

FCS steam generator support notations referenced throughout this report can be found on Figure-1.

Scope of Examination

Westinghouse conducted in-service nondestructive examinations of the steam generator (SG) tubing at Omaha Public Power District's Fort Calhoun Station Nuclear Power Plant in September and October of 2003. The examinations were performed to assess the condition of the Steam Generators, identify tubes requiring repair, and to provide the necessary information needed to fulfill Technical Specification requirements.

The examination program included multi-frequency bobbin testing for indications of degradation or dents and motorized rotating probe coil (MRPC) Plus Point® testing for axial and circumferential cracking and further evaluation of detected bobbin indications.

The eddy current data was acquired using the Westinghouse's ANSER Data acquisition software. The data was reviewed by qualified data analysts (QDA) for data quality and converted to Zetec's Eddynet® format for final data analysis. The converted eddy current was transmitted from the site by T-1 data lines to the Westinghouse (primary analysis) data room at the Waltz Mill facility in Madison, PA and the Verner & James (secondary analysis) data room in Snoqualmie, WA where it was independently analyzed by these two groups of analysts. In addition to the primary and secondary analysis, Verner & James preformed a tertiary analysis on the Bobbin Data by using Computerized Data Screening (CDS). This third analysis was to screen for large indications which minimizes the possibility of missing a significant flaw due to human error. Analysis results were then transmitted to Fort Calhoun where discrepancies between the production analyses were resolved by two groups of Level III Resolution Analysts representing primary and secondary analysis groups. All data analysts were certified to a minimum of ECT Level IIA, QDA certified (EPRI Qualified Data Analyst) and successfully passed a practical examination specific to Fort Calhoun Station steam generators. Data Analysts received familiarization training on the data during the Data Analyst Indoctrination, lessons learned from Comanche Peak were incorporated in the introduction. Optical disks with data from Fort Calhoun, similar CE plants, and Indian Point Unit 2 were also available for review. Data analysts were qualified by proficiency examination on Fort Calhoun data and supplementary data from Comanche Peak, Maine Yankee and Indian Point Unit 2 for damage mechanisms not detected to date at Fort Calhoun.

In addition to OPPD's Steam Generator Program Manager, OPPD was represented by two (2) ECT Level III, from MoreTech. They performed as Independent QDAs, who were not part of the Primary, Secondary, or Resolution analysis teams. These analysts were responsible for review, comments and

changes to the Analysis Procedure, and for review of all acquisition and analysis technique sheets. The Independent QDAs reviewed all "I" codes which had been dispositioned to NDD by the Resolution team. They were also responsible for randomly sampling inspection results to ensure proper disposition of resolved indications, to ensure proper reporting, to review repairable indications, and to review and disposition calls which were contested by either the Primary or Secondary analysts. The functions of these Independent Level III's positions were in accordance with EPRI PWR Steam Generator Examination Guidelines, Revision 6.

In addition to the eddy current data acquisition and data analysis' personnel a Tube Integrity Engineer, a Condition Monitoring consulting Analyst, a data sizing analyst, and an Independent Technical Reviewer were part of the Steam Generator inspection team.

To aid in the disposition and characterization of eddy current signals ultrasonic testing was performed on 12 indications in 7 tubes.

The Inspection Plan listed below was developed from the Degradation Assessment (DA) for the 2003 Outage. The DA identified the following Existing Degradation Mechanisms at FCS: Tube Support Denting, Loose Part Wear, Volumetric Indications, Pitting, Circumferential, Outside Diameter Stress Corrosion Cracking (ODSCC) at; Expansion Transitions, Drilled Plate Supports, Axial ODSCC at; Top of Tubesheet (Sludge Collar), Drilled Support Plate Intersections, Dented Eggcrates, Free Span Critical Area, Free Span and Non-dented Eggcrates and Axial PWSCC at Tube Supports.

Potential Degradation Mechanisms include: Mechanical Wear at Tube Supports Axial ODSCC at Dings, U-Bend Cracking, ODSCC at 90 Degree Bends, PWSCC in Tubesheet Expansion Transitions, Tubesheet Crevices Cracking, and Cracking at the Tube Ends of Expanded Tubes.

Bobbin Probe:

100% of all open tubes were tested with a 0.560-inch diameter bobbin probe. Tubes restricted to the 0.560-inch diameter probe were tested from both hot and cold side as far as possible. The restricted region was tested with. Plus Point®. If the full length of a tube could not be completely inspected by a combination of the 0.560 bobbin probe and MRPC Plus Point® it would have been plugged. No tubes required plugging for an incomplete inspection. Bobbin testing was conducted to detect: Support Denting, Loose Part Wear, Volumetric Indications, Pitting, Axial ODSCC at Non-dented Eggcrates, Free Span, Top of Tubesheet (Sludge Collar), Dings $\leq$ 5 Volts, Mechanical Wear at Tube Supports and Axial PWSCC at Supports.

Motorized Rotating Probe Coil (Plus Point®):

100% of tubes at the Hot Leg Top of Tubesheet +3"/-7" were tested for; Circ ODSCC, Axial ODSCC, Volumetric, Mechanical Wear from loose parts, Circ PWSCC, and Axial PWSCC.

100% of Hot Leg drilled support intersections were tested for: Circ ODSCC, Axial ODSCC, Mechanical Wear from loose parts or support structure and Axial PWSCC.

100% of tubes in the Freespan Critical Area from H5 to DBH were tested for Axial ODSCC, Loose Part Wear.

100% of Hot Leg eggcrate supports with dents >3 volts were tested for Circ ODSCC, Axial ODSCC, Mechanical Wear from lose parts or support structure and Axial PWSCC.

100% of Vertical Supports V1, V2, V3, and DBH and DBC with dents > 3 volts were tested for Circ ODSCC, Axial ODSCC, Mechanical Wear from support structure and Axial PWSCC.

100% of Hot Leg square bends in Critical Area were tested for Axial ODSCC at 90^0 Bends.

100% of Rows 1-2 U-bends were tested with a high frequency Plus Point® for: Circ PWSCC and Axial PWSCC.

20% of Rows 1-4 U-bends were tested with medium frequency Plus Point® for: Circ ODSCC, Axial ODSCC, and Axial PWSCC.

100% of Hot Leg Freespan Dings > 5 volts, were tested for: Circ ODSCC, and Axial ODSCC.

100% of all Bobbin I-codes were tested for: Loose Parts Wear, Volumetric Indications, Pitting, and ODSCC at Expansion Transitions, Drilled Plate Supports, Axial ODSCC at Top of Tubesheet (Sludge Collar), Drilled Support Plate Intersections, Dented Eggcrates, Free Span Critical Area, Free Span and Non-dented Eggcrates and Axial PWSCC at Tube Supports.

20% of indications dispositioned by Plus Point® history for confirmation of the validity of Dispositioned by History (DBH) of bobbin calls that have not changed.

Inspection Plan Expansions

A 25 tube expansion to the Freespan Critical Area of S/G RC-2A was examined because of an indication in a tube at the edge of the critical area. This expansion met the EPRI Rev. 6 requirement to maintain a buffer zone to a Critical Area as described in section 3.6.2.

A 20% sample of all open tubes that pass through the Cold Leg 8^{th} Drilled support intersection in S/G RC-2B were tested because of Circumferential Indications at the 8^{th} Drilled support intersection on the Hot Leg side. This expansion was a conservative decision by FCS to insure that the hot leg mechanism was not present on the cold leg.

Inspection Equipment and Techniques

Westinghouse Electric Company performed the nondestructive examination (NDE) of the steam generator (SG) tubes. The following components are required to perform eddy current testing: an eddy current tester, a remote positioning device, and an eddy current probe drive control system. The state-of-the-art equipment used at OPPD during the 2003 outage for the eddy current testing (ECT) included the Zetec MIZ-70® digital ECT tester. The Flat Rail GENESIS robot manipulator equipped

with the Vision Tube Locating system is used to position the probe at the tubes. Probes are inserted and withdrawn using a Zetec 10D probe pusher equipped with a Westinghouse probe encoders and the Westinghouse Single Probe Pusher Control (SPPC) system. The software that was used for acquisition was the Westinghouse's ANSER Data Acquisition software. The raw data was converted to Zetec's Eddynet98® for data analyst and interpretation.

The ECT probes used included a standard bobbin probe (A560M/ULC), beaded combo probe (A560 M/ULC/C) and spring flex bobbin probes (A560SFRM) for the full-length and partial length inspections. Due to the support denting that occurred in the initial few cycles of operation downsized bobbin probes are used for the examination. A 0.560 inch diameter probe has been used for approximately 97% of the tubes which provides a fill factor of 73%. In past outages a .540 inch diameter probe was used for the remaining bobbin exams. Because the diameter of the probe is reduced there is inherently more probe wobble which produces a horizontal signal response that can mask small amplitude dents. The 3 volt reporting threshold was selected in 1998 as that level at which a dent could be reliably differentiated from probe wobble. This outage only .560 inch diameter probes were used at FCS as described in Reference 2 (LIC-03-0100).

The frequencies used for the bobbin examination are as follows:

400 kHz differential and absolute
200 kHz differential and absolute
100 kHz differential and absolute
35 kHz differential and absolute
400/100 kHz differential support ring mix
400/100 kHz absolute support ring mix

The primary frequency of 400 kHz satisfies the requirements of the ASME Boiler and Pressure Vessel Code for the examination of nonferromagnetic steam generator tubing. A technique using the differential support mix and a voltage base of 2.75 volts on the 20% outer diameter (OD) ASME signal was used to perform dent sizing consistent with current industry techniques. The 100 kHz is provided for the confirmation of flaw indications and as a frequency used in the mixes to eliminate support and OD deposit signals. The 100 kHz absolute detects gradual wall thickness variations. The 200 kHz frequency is for confirmation of flaw indications. The 35 kHz is provided to facilitate locating the probe position in the steam generator. The 400/100 kHz differential mix is used to eliminate the tube support signal and OD tube deposits. The 400/100 absolute mix is used to detect gradual wall loss. Bobbin exams were conducted to conform to EPRI Rev. 6 Appendix H ETSS #s 96008.1 Rev. 13, 96005.2 Rev. 8, 96012.1 Rev.9, 96004.1 Rev.9 and Westinghouse document # SG-99-03-005, Appendix H, Certification of Bobbin Coil Detection Performance in Freespan Dings South Texas Project, dated March 1999.

Three coil motorized rotating coils were used at the hot leg top-of-tubesheet and to investigate bobbin indications. Various versions of the rotating coil probe were used to inspect the vertical runs, horizontal runs, and square bend sections as required. Low row U-bends were also inspected with rotating coil technology.

Top-of-Tubesheet examinations were conducted to conform to EPRI Rev. 6 Appendix H ETSS #s 21409.1 Rev.2, 21410.1 Rev.3, 20510.1 Rev.4, and 20511.1 Rev. 6. The frequencies used for the three coil (P115A, PP11A, P080B), Top-of-Tubesheet examinations are as follows:

400 kHz Pancake, Mid-Freq. Plus Point® coil, and High-Freq. Pancake coil
300 kHz Pancake, and Mid-Freq. Plus Point® coil
100 kHz Pancake, and Mid-Freq. Plus Point® coil
700 kHz High-Freq. Pancake coil
20 kHz Pancake, and Mid-Freq. Plus Point® Coil

Plus Point® exams were conducted to conform to EPRI Rev. 6 Appendix H ETSS #s 21409.1 Rev.2, 21998.1 Rev. 2, 22841.3 Rev. 3, 22842.3 Rev. 3, and 96703.1 Rev. 13. The frequencies for the two coil (2-PP11A) modular probe were as follows:

400 kHz High-Freq. Plus Point® coil
300 kHz High-Freq. Plus Point® coil
100 kHz High-Freq. Plus Point® coil
20 kHz High-Freq. Plus Point® coil

Plus Point® exams were conducted to conform to EPRI Rev. 6 Appendix H ETSS #s 21409.1 Rev.2, 21998.1 Rev. 2, 22841.3 Rev. 3, 22842.3 Rev. 3 and 96703.1 Rev. 13. The frequencies for the 2 coil (P115A, PP11A) Flex probe MRPC examinations were as follows:

400 kHz Pancake, and Mid-Freq. Plus Point® coil
300 kHz Pancake, and Mid-Freq. Plus Point® Coil
200 kHz Pancake, and Mid-Freq. Plus Point® coil
100 kHz Pancake, and Mid-Freq. Plus Point® coil
20 kHz Pancake, and Mid-Freq. Plus Point® Coil

Plus Point® exams were conducted to conform to EPRI Rev. 6 Appendix H ETSS #s 96511.1, 96511.2 Rev. 13. The frequencies used for the single coil (PP11A) mid-frequency U-bend examinations were as follows:

400 kHz Mid-Freq. Plus Point® coil
300 kHz Mid-Freq. Plus Point® coil
200 kHz Mid-Freq. Plus Point® coil
100 kHz Mid-Freq. Plus Point® coil
20 kHz Mid-Freq. Plus Point® coil

Plus Point® exams were conducted to conform to EPRI Rev. 6 Appendix H ETSS # 99997.1 Rev. 7. The frequencies used for the single coil (PP9A) high frequency U-bend examinations were as follows:

800 kHz High-Freq. Plus Point® coil
600 kHz High-Freq. Plus Point® coil

400 kHz High-Freq. Plus Point® coil
300 kHz High-Freq. Plus Point® coil

The recorded multi-frequency eddy current data is analyzed by two independent teams of data analysts for the presence of flaw indications and dents. Discrepancies between the two sets of evaluation results are reviewed and dispositioned by the resolution analysts. Primary and secondary analyst feedback was accomplished through the use of the Analyst Performance Tracking Software. The primary and secondary analysts were required to review all missed calls and a sample of overcalls. If there were any calls which were dispositioned as requiring no further action by the resolution team which the primary or secondary analyst felt should have remained, that analyst could appeal the call and the appeal was then assigned to the independent Level III QDA for final disposition.

The bobbin probe is used primarily as a screening tool to flag indications for further evaluation by means of historical reviews and/or additional testing with rotating coil technology. All of the data for all examined regions was analyzed. Indications left in service have been determined to be either non-reportable or manufacturing related through the use of diagnostic testing and historical reviews. Indications were not left in service based on depth sizing estimates.

Bobbin testing was performed mainly from the outlet side of each S/G. Bobbin test speeds ranged from 12" to 36" per second and varied depending on presence of dents or low row diameter restrictions. Bobbin test sampling rates were within the requirements of the EPRI Appendix H approved techniques. The .560 diameter probe was used on all open tubes; some tubes could not be tested full length with the bobbin coil because of restrictions (dents). Any tube with a restriction was tested to the extent possible from both, outlet and inlet sides, any area that could not pass the bobbin coil was tested with Plus Point® MRPC probe.

MRPC test speeds also varied depending on test location and probe type. Test speeds were from .1" to .7"/second axially with the sampling rate adjusted in accordance with EPRI Appendix H Qualified Techniques as detailed in analysis procedure.

Inspection Results

The #s and locations of each type of indication found are summarized in Table 1. Definitions of indication acronyms can be found in the Appendix. All pluggable indications are reported in Tables 2 and 3. Depth estimates were made only on pluggable indications for the purpose of providing input to assessments of overall steam generator condition. No tubes were left in service on the basis of sizing.

As a result of the inspection, several conclusions can be derived as follows:

Single Axial Indications (SAI) and *Multiple Axial Indications* (MAI) are linear indications that are parallel to the length of the tube or axially oriented. There were 112 SAI (45 in S/G RC-2A and 67 in S/G RC-2B) and 2 MAI (both in S/G RC-2B) reported by the data analyst at various elevations of both steam generators. 67 of the indications were "freespan" (FS) or between supports, 20

indications were at Drilled Support Plates (DSP), 17 indications at Eggcrate (EC) supports structures and 8 indications were within 2 inches of the top of the hot leg tubesheet (HTS). The majority of the indications reside between H5 and H8 in the critical area where the partial tube support plates are superpositioned. Most of these indications were transparent to the bobbin coil and were detected with the more sensitive rotating Plus Point® coil. The deepest indication which was not detected by the bobbin coil was 55% as sized by Plus Point® amplitude. This indication was at a dent where bobbin performance is degraded from liftoff. The deepest indication missed by the bobbin coil where no denting is present was 46%. Historical data reviews from the RFO-02 inspection were conducted by the senior analyst during the course of the RFO-03 examination. Of the 114 indications all were reviewed to determine whether the flaw was present and if so, did it appear to grow. 58 indications showed no growth, 23 showed growth, 13 showed marginal growths. 20 indications which were detected by the Plus Point® coil only, could not be reviewed because that area of the tube had not been tested by Plus Point® in 2001 or 2002. The number of indications reported in documents, like the Condition Monitoring Assessment (report number SG-SGDA-03-041) and Operational Assessment for Cycle 22 (report number SG-SGDA-04-02), were adjusted; if the ECT graphics indicated that indications were close together axially and co-linear, then they were considered one indication with a size that enveloped the multiple ECT indications.

Single Circumferential Indications (SCI's) are linear indications perpendicular to the length of the tube or circumferentially oriented. 25 SCI indications were reported, (10 in S/G RC-2A and 15 in S/G RC-2B). Two (2) of the indications were at the top of the hot leg tubesheet (HTS), both were in S/G RC-2A. One indication was at the 7th eggcrate support structure in S/G RC-2B. Four (4) indications in S/G RC-2B are considered freespan because they are not encompassed by a support structure. The remaining indications were at various hot leg drilled support plates. Several circumferential indications in S/G B at the 8th drilled support plates appeared to be a series of parallel circumferential cracks over an axial distance nearly the length of the support thickness. The maximum circumferential extent of the HTS indications was 40 degrees and the maximum indicated depth by Plus Point® phase analysis was 75% through-wall. The maximum circumferential extent of the drilled support plate indications was 137 degrees and the maximum indicated depth by Plus Point® phase analysis was 71% through-wall. Of the 18 SCI indications reported at drilled supports, 14 are associated with a dent from the bobbin coil. The dent voltages range from 3.40 volts to 120.7 volts. Several of the indications showed growth from the last cycle.

Single Volumetric Indications (SVI) are band or patch like indications. 3 SVI's were reported (1 in S/G RC-2A and 2 in S/G RC-2B). All three indications were freespan and showed no change from 2002 data. The indication in S/G RC-2A was located above the fifth hot leg support structure and the two indications in S/G RC-2B were located above the sixth hot leg support structure. This is the region where axial ODSCC occurs and the damage mechanism which produced the ECT indications is presumed to be a patch of inter-granular attack (IGA).

Loose Part With Indication (LPI) is a flaw indication associated with a loose part. 2 tubes in S/G RC-2A were plugged because of wear from loose part like indications.

All of the tubes with the above indications were repaired by plugging. Tubes with circumferential indications were stabilized as well. A total of 42 tubes were plugged in S/G RC-2A and 65 tubes

were plugged in S/G RC-2B, there were 4 additional tubes plugged in both steam generators to facilitate future use of the flat-rail system. A total of 115 tubes were plugged this outage.

In-Situ Pressure Test and Results

Insitu pressure testing was performed on one (1) tube in SG RC-2B (Row 94, Line 65, at the H8 Support). The test was performed due to the eddy current detection of multiple layer cracking. One of the indication layers measured 1.07 volts which exceeded initial the leak test screening threshold of 1.0 volts. The tested area withstood the required pressure with no leakage, thereby assuring that the condition monitoring criteria were satisfied. The test was performed in accordance with procedure STD-400-173 titled "Checkout and Operation of the Steam Generator Tube In Situ Pressure Test System" and traveler CFTC1-SG-004 titled "In Situ Pressure Test Using the Computerized Data Acquisition System". Table 4 is a summary of the test and target pressures.

Conclusions

Based on the results of the extensive eddy current examination and the in-situ pressure tests performed, OPPD has reached the conclusion that the steam generator tube performance criteria were met for the entire previous operating cycle, and the requirements for conditioning monitoring were fulfilled.

All tubes with identified degradation were plugged. Tubes with circumferential indications were stabilized. No tubes were repaired by sleeving. To date, S/G RC-2A has a total of 308 tubes plugged (6.16%), and S/G RC-2B has a total of 340 tubes plugged (6.8%).

Steam Generator											
Indication Listing by Location											
	S/G RC-2A					S/G RC-2B					
Location	SAI / MAI	SCI	SVI	LPI	VOL	SAI / MAI	SCI	SVI	LPI	VOL	Totals
HTS	6	2		2		2					12
HTS+						1					1
H1	5	3				5	1				14
H1+											0
H2						3	1				4
H2+											0
H3						2					2
H3+											2
H4						2	1				3
H4+						2					2
H5	1					7					8
H5+	4		1			2					7
H6	4	2				6					12
H6+	3					10	1	2			16
H7	5	2				3	2				12
H7+	15					9 / 2					26
H8		1				6	9				16
H8+	2					2					4
DBH											0
DBH+											0
V1											0
V1+						1					1
V2											0
V2+						4					4
V3											0
V3+											0
DBC											0
DBC-											0
C8+											0
C8											0
C7+											0
C7											0
C6+											0
C6											0
C5+											0
C5											0
C4+											0
C4											0
C3+											0
C3											0
C2+											0
C2											0
C1+											0
C1											0
CTS+											0
CTS											0
Totals	45 / 0	10	1	2	0	67 / 2	15	2	0	0	144
	SAI / MAI	SCI	SVI	LPI	VOL	SAI / MAI	SCI	SVI	LPI	VOL	

Table 2

Fall 2003 Outage **S/G RC-2A Plug List**

	Row	Line	2003 Bobbin call P1 Call	2003 MRPC call	Volts	Deg	%	Circ Deg	Axial	Sup	02 MRPC Data	03 Dent
1	3	44		**TBP Flat Rail**								
2	3	58		**TBP Flat Rail**								
3	9	94	NDD	**SCI HTS + 0.18**	0.16	87	63	28		HTS	No Change	None
4	11	30	NDD	**SCI HTS + 0.09**	0.14	89	75	40		HTS	No Change	None
5	15	44		**TBP Flat Rail**								
6	15	58		**TBP Flat Rail**								
7	16	63	NDD	**SAI HTS + 0.28**	0.17	83	25		0.14	HTS	Change	None
8	23	58	NDD	**SAI HTS + 0.49**	0.2	101	30		0.32	HTS	No Change	None
9	25	56	NDD	**SAI HTS + 0.81**	0.16	111	24		0.2	HTS	No Change	None
10	30	73	NDD	**SAI HTS + 1.70**	0.22	102	28		0.26	HTS	Change	None
11	33	74	NDD	**SAI HTS + 1.55**	0.23	132	31		0.26	HTS	No Change	None
12	35	74	NDD	**SAI HTS + 1.73**	0.15	127	26		0.19	FS	No Change	None
13	56	81	NDD	**SAI H6 + 0.32**	0.42	119	39		0.42	EC	No History	4.44 V
14	61	50	NDD	**SAI H7 + 0.10**	0.39	87	40		0.2	EC	No History	9.07 V
15	81	62	NDD	**SAI H1 - 0.59**	0.23	109	31		0.61	FS	No Change	54.09 V
16	85	68	NDD	**SAI H5 + 37.97**	0.17	85	21		0.17	FS	No Change	None
17	86	47	NDD	**SAI H7 + 10.18**	0.19	121	28		0.29	FS	No Change	None
			NDD	**SAI H7 + 11.05**	0.16	114	26		2.25	FS	No Change	None
18	87	56	NDD	**SAI H5 + 36.24**	0.11	106	24		0.26	FS	No Change	None
19	87	60	NDD	**SAI H5 + 37.22**	0.14	92	25		0.22	FS	Change	None
20	90	55	NDD	**SAI H7 + 11.54**	0.16	125	29		0.58	FS	Change	None
			NDD	**SAI H7 + 14.57**	0.27	94	36		0.88	FS	Change	None
			NDD	**SAI H7 + 1.61**	0.13	124	16		0.51	FS	No Change	None
			NDD	**SAI H7 + 10.81**	0.26	106	26		1.27	FS	No Change	None
			DBH +4.83 0.43V 101D	**SAI H7 + 3.52**	0.15	127	17		0.4	FS	No Change	None
			NDD	**SAI H7 + 9.91**	0.55	113	42		0.46	FS	No Change	None
21	90	59	NDD	**SAI H6 - 0.92**	0.28	121	34		0.35	FS	Change	34.63 V
			NDD	**SAI H6 - 0.23**	0.68	119	52		0.41	DSP	No Change	34.63 V
22	90	63	NDD	**SAI H7 + 12.76**	0.15	90	28		0.9	FS	No Change	None
23	90	71	NDD	**SAI H7 + 9.18**	0.21	138	30		0.21	FS	No Change	None
24	90	77	NDD	**SCI H1 - 0.15**	0.33	100	53	70		DSP	No Change	34.13 V
25	91	58	NDD	**SAI H6 + 0.1**	0.76	116	54		0.72	DSP	No Change	53.83 V
26	91	64	NDD	**SAI H5 +35.59**	0.28	112	34		0.74	FS	No Change	None
27	93	58	DSI H8 + 0.05 3.15V 38D	**SCI H8 - 0.24**	0.24	105	53	33		DSP	No Change	6.13 V
28	93	76	NDD	**SAI H7 - 0.22**	0.21	89	28		0.22	DSP	No Change	None
29	93	82	INR H1 +0.47 1.25V 54D	**SAI H1 +1.42**	0.16	79	24		0.43	DSP	Marginal Change	6.35V
30	94	41	NDD	**LPI HTS + 3.12**	0.32	108	26	34	0.56	FS	No Change	None
31	94	61	NDD	**SAI H6 + 18.74**	0.15	93	25		0.33	FS	No Change	None
			NDD	**SAI H6 + 21.43**	0.12	111	23		0.79	FS	No Change	None
			NDD	**SAI H7 + 2.65**	0.34	123	43		4.06	FS	No Change	None
32	94	83	NDD	**SAI H1 + 1.42**	0.26	117	27		0.51	DSP	No Change	None
33	95	42	DFI HTS + 2.64 0.53V 115D	**LPI HTS + 2.51**	0.19	132	19	32	0.39	FS	No Change	None
34	96	41	NDD	**SVI H5 + 32.01**	0.12	132	16	29	0.19	FS	No Change	None
			NDD	**SVI H5 + 32.07**	0.25	121	22	33	0.59	FS	No Change	None
35	96	55	NDD	**SAI H7 + 9.99**	0.07	97	26		0.18	FS	No Change	None
36	96	67	NDD	**SAI H5 + 0.26**	0.25	114	33		0.22	DSP	No Change	None
37	96	71	NDD	**SAI H7 +13.94**	0.17	111	28		0.33	FS	No Change	None
			NDD	**SAI H7 + 13.92**	0.1	119	23		0.15	FS	No Change	None
			NDD	**SAI H7 + 15.37**	0.18	104	29		0.36	FS	No Change	None

Table 2 (cont)

Fall 2003 Outage **S/G RC-2A Plug List**

	Row	Line	2003 Bobbin call P1 Call	2003 MRPC call	Volts	Deg	%	Circ Deg	Axial	Sup	02 MRPC Data	03 Dent
37	96	71	NDD	**SAI H7 + 16.34**	0.18	107	29		0.27	FS	No Change	None
38	97	46	NDD	**SAI H7 + 0.01**	0.28	113	33		0.17	DSP	No Change	3.09 V
39	97	50	NDD	**SAI H7 + 0.01**	0.53	130	46		0.43	DSP	No Change	None
40	97	68	NDD	**SAI H6 + 13.51**	0.19	113	31		0.34	FS	No Change	None
41	98	59	NDD	**SCI H1 + 0.27**	0.35	107	50	70		DSP	Marginal Change	12.57 V
42	98	71	NDD	**SCI H6 + 0.19**	0.36	108	20	125		DSP	No Change	3.57 V
43	100	69	NDD	**SAI H1 + 0.03**	0.23	112	36		0.52	DSP	No Change	None
44	101	70	DSI H1 -0.09 1.00V 39D	**SAI H1 +0.00**	0.16	103	26		0.52	DSP	Marginal Change	None
			NDD	**SCI H7 + 0.00**	0.2	77	62	71		DSP	Marginal Change	None
			NDD	**SCI H6 - 0.07**	0.31	83	62	105		DSP	No Change	None
45	102	55	NDD	**SAI H8 + 11.18**	0.13	116	18		0.23	FS	No Change	None
			DFI H8 +16.0 0.16V 111D	**SAI H8 + 15.61**	0.15	81	25		0.19	FS	No Change	None
			NDD	**SCI H7 + 0.12**	0.34	114	34	42		DSP	No Change	None
46	103	64	INR H1 +0.43 1.06V 105D	**SCI H1 + 0.00**	0.23	119	27	64		DSP	No Change	13.25 V

Table 3

Fall 2003 Outage — **S/G RC-2B Plug List** — Page 1 of 2

	Row	Line	2003 Bobbin call P1 Call	2003 MRPC call	Volts	Deg	%	Circ Deg	Axial	Sup	02 MRPC Data	03 Dent
1	3	44		**TBP Flat Rail**								
2	3	58		**TBP Flat Rail**								
3	9	72	NDD	**SAI HTS + 0.21**	0.4	93	43		0.28	HTS	No Change	None
			NDD	**SAI HTS + 0.45**	0.14	118	35		0.24	HTS	No Change	None
4	15	44		**TBP Flat Rail**								
5	15	58		**TBP Flat Rail**								
6	16	73	NDD	**SAI H5 + 1.68**	0.18	103	23		0.24	FS	No History	None
7	20	55	NDD	**SAI H5 - 0.45**	0.27	107	34		0.25	EC	No History	10.33 V
8	23	22	NDD	**SAI H1 + 0.40**	0.57	114	46		0.47	EC	No Change	14.60 V
9	23	44	NDD	**SAI H6 + 0.43**	0.63	109	45		0.31	EC	Change	14.76 V
10	23	62	NDD	**SAI H5 + 2.69**	0.32	123	34		0.48	FS	Change	5.58 V
11	23	112	NDD	**SAI H5 - 0.34**	0.28	125	36		0.21	EC	No History	8.57 V
12	25	70	NDD	**SAI H6 + 0.58**	0.59	112	49		0.23	EC	No History	23.11 V
13	27	114	NDD	**SAI H5 +1.24**	0.27	111	30		0.54	FS	No History	None
14	28	33	NDD	**SAI H4 - 0.08**	0.4	112	39		0.4	EC	No History	4.96V
15	31	46	NDD	**SAI H5 + 0.25**	0.49	105	44		0.2	EC	No Change	7.81 V
16	36	33	NDD	**SAI H2 + 0.64**	0.55	112	41		0.12	EC	Marginal Change	11.19 V
17	47	116	NDD	**SAI V2 + 4.75**	0.39	119	39		0.28	FS	No History	None
18	48	39	NDD	**SAI H4 + 5.22**	0.29	125	33		0.44	FS	No History	None
19	54	51	NDD	**SAI H6 + 1.15**	0.69	86	51		0.17	FS	No History	7.55 V
20	55	70	NDD	**SAI V2 + 3.92**	0.25	121	29		0.32	FS	No History	None
21	55	74	NDD	**SAI V2 - 3.62**	0.27	127	30		1.24	FS	No History	None
22	56	79	NDD	**SAI H6 - 0.34**	0.45	128	36		0.64	EC	No History	7.01 V
23	63	60		**SAI V2 + 12.74**	0.39	145	42		0.85	FS	No History	None
			DFI V2 + 11.3 0.40V 84D	**SAI V2 +10.90**	0.53	143	44		0.68	FS	No History	None
24	66	53	DSI H1 - 0.31 1.03V 70D	**SAI H1 - 0.31**	0.45	122	50		0.47	EC	No History	None
25	68	69	NDD	**SCI H2 + 0.28**	0.46	112	38	112		DSP	Change	120.7 V
26	70	59	NDD	**SAI H6 - 0.40**	0.3	97	31		0.48	EC	No History	8.23 V
27	71	26	NDD	**SAI H5 - 1.40**	0.38	79	30		0.19	EC	No History	10.93 V
28	71	76	NDD	**SAI H5 + 0.81**	0.7	132	55		0.7	EC	No History	4.28 V
29	76	43	NDD	**SAI H8 - 0.02**	0.28	92	32		0.35	DSP	Change	None
30	76	39	NDD	**SAI H8 + 0.16**	0.23	108	29		0.27	DSP	Change	None
31	76	81	NDD	**SAI H2 + 0.22**	0.57	117	41		0.57	EC	Change	13.38 V
32	78	61	NDD	**SAI H1 -0.57**	0.31	116	35		0.63	FS	No Change	None
33	79	68	NDD	**SAI H2 + 0.00**	0.22	100	29		0.51	DSP	No Change	None
34	80	59	NDD	**SAI H6 + 20.60**	0.22	76	30		0.44	FS	Change	None
			NDD	**SAI H6 + 21.57**	0.21	117	29		0.22	FS	No Change	None
35	81	84	NDD	**SAI HTS + 2.89**	0.11	113	21		0.41	FS	No Change	None
36	83	58	NDD	**SAI H4 + 2.89**	0.23	121	33		0.25	FS	No Change	None
37	84	37	NDD	**SCI H8 + 0.17**	0.23	89	62	49		DSP	Marginal Change	32.65 V
38	84	57	NDD	**SAI H5 + 34.69**	0.43	92	41		0.78	FS	No Change	None

Table 3 (Cont.)

Fall 2003 Outage **S/G RC-2B Plug List**

	Row	Line	2003 Bobbin call P1 Call	2003 MRPC call	Volts	Deg	%	Circ Deg	Axial	Sup	02 MRPC Data	03 Dent
39	84	73	NDD	SCI H7 - 4.61	0.19	101	49	27		FS	No Change	None
			NDD	SCI H7 -1.16	0.4	95	57	79		EC	No Change	5.32 V
			NDD	SVI H7 -2.40	0.21	87	29			FS	No Change	None
			NDD	SVI H7 -4.93	0.22	110	29			FS	No Change	None
40	84	75	NDD	SAI H4 - 1.40	0.78	110	51		0.56	EC	Change	9.29 V
41	86	67	NDD	SAI H8 +0.00	0.39	73	40		0.34	DSP	No Change	16.72 V
42	87	52	NDD	SCI H4 - 1.10	0.27	109	33	21		FS	Marginal Change	6.30 V
43	87	62	NDD	SAI H7 + 2.85	0.22	97	28		0.4	FS	No Change	None
44	89	70	NDD	SAI H8 + 1.26	0.35	128	38		0.81	FS	No Change	7.76 V
			NDD	SAI H8 + 3.46	0.2	128	32		0.51	FS	No Change	None
45	90	61	NDD	SCI H8 + 0.36	0.45	84	71	34		DSP	No Change	45.45 V
46	90	77	NDD	SCI H1 - 0.03	0.29	126	30	51		DSP	Marginal Change	None
47	91	52	NDD	SAI H7 + 0.73	0.42	100	36		0.84	FS	Change	14.5 V
48	91	54	NDD	SAI H3 + 0.15	0.31	122	35		0.25	DSP	No Change	None
49	91	56	NDD	SAI H1 - 0.18	0.17	102	26		0.41	DSP	Marginal Change	None
50	91	74	NDD	SAI H8 - 0.92	0.53	121	46		0.6	FS	No Change	None
51	92	59	NDD	SAI H6 + 1.57	0.2	108	27		0.26	FS	Marginal Change	None
			NDD	SAI H6 + 2.05	0.26	104	30		0.23	FS	Marginal Change	None
			NDD	SAI H6 + 2.25	0.29	71	27		0.2	FS	Marginal Change	None
			NDD	SAI H6 + 2.74	0.3	73	30		0.6	FS	Marginal Change	None
52	92	65	NDD	SAI H7 + 13.04	0.16	80	26		0.16	FS	Change	None
			NDD	SAI H7 + 15.90	0.23	93	31		0.25	FS	Change	None
53	92	69	NDD	SAI H7 + 16.03	0.17	71	26		0.78	FS	Marginal Change	None
54	92	73	NDD	MAI H7 + 13.92	0.13	55	25		0.21	FS	Change	None
			NDD	MAI H7 + 14.99	0.2	122	28		0.47	FS	Marginal Change	None
			NDD	SAI H7 + 12.01	0.25	111	32		0.57	FS	Marginal Change	None
			NDD	SAI H7 + 14.11	0.23	99	31		0.2	FS	Change	None
			NDD	SAI H7 + 14.22	0.22	90	31		0.2	FS	Change	None
55	93	64	NDD	SAI H7 + 3.15	0.2	98	26		0.39	FS	No Change	None
			NDD	SAI H7 + 4.25	0.16	107	22		0.33	FS	No Change	None
56	93	66	NDD	SAI H7 + 0.88	0.28	116	25		0.32	FS	No Change	14.93 V
			NDD	SCI H8 + 0.18	0.45	129	8	101		DSP	No Change	3.40 V
57	94	61	NDD	SAI H8 - 0.11	0.44	132	41		0.46	DSP	No Change	15.55 V
			NDD	SCI H7 + 0.67	0.19	105	39	42		FS	No Change	None
			NDD	SCI H8 + 0.27	0.57	110	31	114		DSP	No Change	15.55 V
58	94	63	NDD	SCI H8 + 0.11	0.71	95	53	134		DSP	No Change	19.11 V
59	94	65	NDD	SCI H8 + 0.06	1.07	106	43	137		DSP	Change	7.94 V
60	95	58	NDD	SAI H6 + 18.57	0.14	81	24		0.19	FS	No Change	None
			NDD	SAI H6 + 19.76	0.14	84	22		0.49	FS	No Change	None
			NDD	SAI H6 + 20.82	0.22	115	30		0.49	FS	No Change	None
61	95	64	NDD	SCI H8 - 0.60	0.28	90	62	38		FS	No Change	10.46V
62	95	66	NDD	SCI H8 + 0.14	0.73	109	42	111		DSP	Change	6.84 V
63	95	70	NDD	SAI H6 + 20.67	0.24	118	28		0.43	FS	Change	None
64	96	65	NDD	SCI H8 - 0.32	0.25	131	8	44		DSP	Marginal Change	4.06 V
65	98	83	NDD	SAI H6 + 20.00	0.52	135	46		0.26	FS	Marginal Change	None
66	99	62	NDD	SAI H8 + 2.33	0.15	120	27		0.31	FS	Marginal Change	None
67	100	69	NDD	SAI H3 + 0.17	0.51	138	45		0.71	DSP	Change	None
68	101	72	NDD	SAI H7 + 0.3	0.26	113	34		0.29	DSP	Change	14.10 V
69	102	63	NDD	SAI H1 - 0.13	0.23	102	35		0.32	DSP	No Change	None

Table 4 – Summary of the In Situ Pressure Testing

Location		Steam Generator B
Row		94
Line		65
Test Pressure		
NODP	Target	1,609
	Achieved	1,700
	Ramp Rate	61 psi/sec
SLBP	Target	2,710
	Achieved	2,750
	Ramp Rate	51 psi/sec

APPENDIX

DEFINITIONS

The acronyms defined below are used in Tables 1 through 4.

DFI: Differential Freespan Indication – An indication in the freespan that gives a flaw-like response on the bobbin coil (diagnostic/review required)

DSI: Distorted Support Indication (diagnostic/review required)

INR: Indication not reportable (diagnostic/review required)

MAI: Multiple Axial Indication – Axial indications in the same plane (pluggable)

NDD: No detectable degradation (no further action required)

SAI: Single Axial Indication – Axially oriented crack-like indication (pluggable)

SCI Single Circumferential Indication – Circumferentially oriented crack-like indication (pluggable)

SVI: Single Volumetric Indication – Indication which represents that volumetric (non-oriented) degradation is present (pluggable)

TBP: To be plugged

VOL: Volumetric – Indication which is volumetric in nature and generally associated with tube manufacturing (diagnostic/review required)

Figure 1
FORT CALHOUN
STEAM GENERATOR ELEVATION DRAWING

HTE Hot leg Tube End
HTS Hot Leg Tubesheet
H1-H6 Hot Leg Full Supports
H7 Hot Leg Partial Egg Crate
H8 Hot Leg Partial Drilled Support
DBH Diagonal Bar Hot Leg

V1-V3 Vertical Supports

DBC Diagonal Bar Cold Leg
C8 Cold Leg Partial Drilled Support
C7 Cold Leg Partial Egg Crate
C6-C1 Cold Leg Full Supports
CTS Cold Leg Tubesheet
CTE Cold leg Tube End