

February 12, 2003

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

Subject: Oconee Nuclear Station, Unit 2  
Docket No. 50-270  
End-of-Cycle19 Refueling Outage, November 2002  
Steam Generator Inservice Inspection Summary Report

Enclosed is a copy of the Steam Generator Tube Inservice Inspection Summary Report for the subject refueling outage. This Summary Report is provided per American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Article IWA-6230.

Please address questions to R. C. Douglas at (864) 885-3073.

Very truly yours,

  
R. A. Jones  
Site Vice President

Enclosure

A047

xc w/attachments:            Mr. Luis A. Reyes  
   Regional Administrator, Region II

xc w/o attachments:        Mr. M. C. Shannon  
   NRC Senior Resident Inspector

   Mr. L. N. Olshan  
   ONRR, Senior Project Manager

   Mr. Virgil R. Autry  
   DHEC

## Enclosure

### Oconee Unit 2 End-of-Cycle 19 Steam Generator Inservice Inspection Summary Report

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***Steam Generator  
In-service Inspection Summary Report***

***Oconee Unit 2 2002  
Outage EOC 19***

Location: 7800 Rochester Highway, Seneca, South Carolina 29672

NRC Docket No. 50-270

National Board No. N/A

Commercial Service Date: September 9, 1974

Owner: Duke Energy Corporation  
526 South Church St.  
Charlotte, N.C. 28201-1006

Revision 0

Prepared By: James H. Patton Date: 12/11/02

Reviewed By: Daniel B. Mays Date: 12/16/02

Approved By: William S. Sample Date: 12/16/02

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*Distribution  
for  
Steam Generator  
In-service Inspection Summary Report  
Oconee Unit 2 2002  
Outage EOC 19*

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2	Hartford Steam Boiler Of Connecticut (AIA)
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**FORM NIS-1 OWNER'S DATA REPORT FOR INSERVICE INSPECTIONS**

**As required by the Provisions of the ASME Code Rules**

1. Owner: Duke Energy Corporation, 526 S. Church St. Charlotte, NC 28201-1006  
(Name and Address of Owner)
2. Plant: Oconee Nuclear Station, 7800 Rochester Highway, Seneca, SC 29672  
(Name and Address of Plant)
3. Plant Unit: 2
4. Owner Certificate of Authorization (if required)      N/A
5. Commercial Service Date: September 9, 1974
6. National Board Number for Unit N/A
7. Components Inspected:

<u>Component</u>	<u>Manufacturer</u>	<u>Manufacturer Serial No.</u>	<u>State or Province No.</u>	<u>National Board No.</u>
Steam Generator A	Babcock & Wilcox	620-0004-55-2	N/A	N-108
Steam Generator B	Babcock & Wilcox	620-0004-55-1	N/A	N-107

Note: Supplemental sheets in form of lists, sketches, or drawings may be used provided (1) size is 8<sup>1</sup>/<sub>2</sub> in. x 11 in., (2) information in items 1 through 6 on this data report is included on each sheet, and (3) each sheet is numbered and the number of sheets is recorded at the top of this form.

FORM NIS-1 (Back)

- 8. Examination Dates: May 14, 2001 TO October 12, 2002
- 9. Inspection Period Identification: Third Period
- 10. Inspection Interval Identification: Third Interval
- 11. Applicable Edition of Section XI: 1989 Addenda None
- 12. Date/Revision of Inspection Plan: Technical Specification 5.5.10 Steam Generator, through 9/5/02 Tech. Spec. Revision
- 13. Abstract of Examinations and Test. Reference attached Steam Generator In-service Inspection Summary Report
- 14. Abstract of Results of Examination and Tests. Reference attached Steam Generator In-service Inspection Summary Report
- 15. Abstract of Corrective Measures. Reference attached Steam Generator In-service Inspection Summary Report

We certify that a) the statements made in this report are correct b) the examinations and tests meet the Inspection Plan as required by the ASME Code, Section XI, and c) corrective measures taken conform to the rules of the ASME Code, Section XI.

Certificate of Authorization No. (if applicable) N/A Expiration Date N/A

Date 12-16 20 02 Signed Duke Energy Corp. By [Signature]  
Owner

CERTIFICATE OF INSERVICE INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State of Province of South Carolina employed by \*The HSB CT have inspected the components described in this Owner's Report during the period 5-14-01 to 2-6-03, and state that to the best of my knowledge and belief, the Owner has performed examinations and tests and taken corrective measures described in the Owner's Report in accordance with the Inspection Plan and as required by the ASME Code, Section XI.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the examinations, test, and corrective measures described in this Owner's Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection

[Signature] Commissions GA 360 NIC  
Inspector's Signature National Board, State, Province, and Endorsements

Date 2-6-2003 ~~20-02-00~~ 2/6/03

\*Hartford Steam Boiler of Connecticut  
200 Ashford Center North  
Suite 300  
Atlanta, GA. 30338

**Attachment to Form NIS-1  
Steam Generator In-service Inspection Summary Report**

**Oconee Nuclear Station Unit 2 – 2002  
Outage EOC-19**

**Steam Generator Tubing Surveillance**

**1.0 Introduction**

Eddy current examinations were performed on the 0.625" OD x 0.037" wall Inconel 600 tubing and the sleeved portion of the tubes in steam generators "A" and "B" at the Oconee Nuclear Station Unit 2 during the October 2002 refueling outage ONS 2 EOC 19.

Framatome ANP DE&S prepared this report as a summary of the eddy current results.

**2.0 Technical Summary**

This section provides a technical summary of the eddy current examinations performed at Duke Energy's, Oconee Nuclear Station, Unit 2 EOC19.

The Inconel 600 tubing in the two Babcock and Wilcox once through steam generators (OTSG's) "A" and "B" were examined by various eddy current techniques. The tubing in the generators measures 0.625 inch nominal outside diameter with a 0.037 inch nominal wall thickness. Personnel from Framatome ANP DE&S, Framatome ANP (FANP), ANATEC, and MoreTech performed the examinations during the 19th refueling outage.

A magnetic-bias bobbin coil examination was performed on 14,661 tubes in steam generator "A" and 14,403 tubes in steam generator "B". All in-service sleeves were examined with a bobbin coil probe. A single coil "plus-point" motorized rotating coil MRPC<sup>®</sup> probe was used to examine sleeve upper and lower rolls. All I-600 and I-690 plugs were visually examined during this refueling outage. Special Interest locations, upper tubesheet rolls and lower tubesheets were examined with two-coil MRPC<sup>®</sup> probe.

A total of 13 tubes were de-plugged and examined in OTSG "A" and 25 in OTSG "B". A magnetic-bias bobbin coil examination was performed after the plug removal. Special interest locations were examined with two-coil MRPC<sup>®</sup> probe.



## 2.1 Summary

The following summarizes the results of eddy current examinations for each steam generator.

**Note:** Attachment 1 contains a list of all three-letter codes and acronyms used throughout this report.

### OTSG A:

- Eddy current examinations began on 10/15/02 @ 0900 and were completed on 10/29/02 @ 1100.
- 430 tubes were removed from service by plugging.
- 14,661 tubes were examined with a bobbin coil probe, does not include de-plugged tubes.
- 2 tubes were reported to have indications of 40% TW or greater with the bobbin coil probe examination.
- 18 tubes were reported to have indications of 20-39% TW with the bobbin coil probe examination.
- 275 sleeves were examined with a bobbin coil probe.
- 275 sleeves were examined with the plus point coil MRPC<sup>®</sup> probe at the upper and lower rolls.
- 207 tubes in the lane/wedge region were examined at the 015 TSP and UTS intersections with a 2-coil MRPC<sup>®</sup> probe.
- 14,386 HLRT were examined with the plus point 2-coil MRPC<sup>®</sup> probe.
- 2034 LTS were examined with the plus point 2-coil MRPC<sup>®</sup> probe.
- 2 LTS Manufacture Re-rolls were examined with the plus point coil MRPC<sup>®</sup> probe.
- 2,182 tubes were examined for SI using the 2-coil MRPC<sup>®</sup> probe.
- 13 de-plugged tubes were examined with a bobbin coil probe.
- 13 de-plugged tubes were examined for SI using the 2-coil MRPC<sup>®</sup> probe.

### OTSG B:

- Eddy current examinations began on 10/16/02 @ 0400 and were completed on 10/30/02 @ 0300.
- 38 tubes were repaired using FTI/ANP "Re-rolling" process
- 560 tubes were removed from service by plugging, 25 tubes were de-plugged in the upper and re-plugged.
- 14,403 tubes were examined with a bobbin coil probe, does not include de-plugged tubes.

- 1 tube was reported to have indications of 40% TW or greater with the bobbin coil probe examination.
- 32 tubes were reported to have indications of 20-39% TW with the bobbin coil probe examination.
- 251 sleeves were examined with a bobbin coil probe.
- 251 sleeves were examined with the plus-point coil MRPC® probe at the upper and lower rolls.
- 201 tubes in the lane/wedge region were examined at the 015 TSP and UTS intersections with the 2-coil MRPC® probe.
- 14,152 HLRT were examined with the plus point 2-coil MRPC® probe.
- 2,085 LTS were examined with the plus point 2-coil MRPC® probe.
- 1 LTS Manufacture Re-roll was examined with the plus point coil MRPC® probe.
- 2,964 tubes were examined for SI using the 2-coil MRPC® probe..
- 25 de-plugged tubes were examined with a bobbin coil probe.
- 25 de-plugged tubes were examined for SI using the 2-coil MRPC® probe.
- 38 Re-rolls were examined for SI using the 2-coil MRPC® probe.

## 2.2 Examinations

The examination, equipment and personnel were in compliance with the requirements of the Framatome ANP DE&S NDE Program Manual for In-service Inspection, the applicable Duke Power Co. Technical Specifications, the ASME Boiler and Pressure Vessel Code Section XI, 1989 Edition and industry standards. Analysis of the eddy current data was performed in accordance with the "Eddy Current Analysis Guidelines for Oconee Nuclear Station Unit 2, EOC-19.

The steam generator tubing examinations were performed by technicians qualified to Level II, or Level I under direct supervision of personnel qualified to Level II in accordance with Framatome ANP DE&S procedure NDE-B. The data was evaluated by personnel qualified to a minimum of Level IIA in accordance with Framatome ANP DE&S procedure NDE-B. The examination and evaluation procedures used during the eddy current examinations were approved by personnel qualified to Level III in accordance with Framatome ANP DE&S procedure NDE-B.

All inspection frequencies were generated using a Zetec MIZ®-30 remote data acquisition unit.

The bobbin coil examinations were performed with .510 inch, .500 inch, and .480 inch diameter probes. The inspection frequencies used were 600, 400, 200 and 35 kHz operating in both differential and absolute modes. A 400/200 kHz differential tube support plate suppression mix was used to enhance the detection of indications occurring at TSP intersections.

The sleeve examinations were performed with a .400 inch diameter bobbin coil probe. The inspection frequencies used were 400, 250, 150 and 75 kHz operating in the differential and absolute mode. A 400/150 kHz differential tube support plate suppression mix was used to enhance the detection of indications occurring at TSP intersections. Sleeve roll expansions were inspected using a .400 inch diameter plus-point coil MRPC<sup>®</sup> probe. The inspection frequencies used were 200, 120, 75 and 50 kHz operating in the differential mode.

The lane & wedge and special interest examinations were performed with .460 inch diameter 2-coil MRPC<sup>®</sup> probes. The inspection frequencies used were 300, 200, 100 and 15 kHz. A 300/100 kHz TSP suppression mix on the pancake coil was used to enhance the detection of indications occurring at TSP intersections.

Official results of the data analysis were recorded on optical disks and verified by two Eddy Current Data Management systems, Framatome Data Management System, (FDMS) and EddyNet<sup>®</sup> Inspection Management System, (EIMS). These systems are used to check the data for invalid analysis entries, perform data sorting routines, ensure all the proper tubes were examined and to printout final data sheets.

### 2.3 Areas of Concern

In OTSG's, certain modes of degradation have been identified in specific regions of the generator.

Eddy current examinations cannot, in all cases, determine the actual cause of damage. The signal recorded during the eddy current examination can be used to estimate the physical size of any tube damage detected (i.e., penetration into the wall, axial extent), however, the actual type of degradation and its cause can only be determined by tube removal and metallurgical studies.

- a) Impingement Erosion – An erosion/corrosion type of discontinuity occurring from the flow of secondary side water with contaminants or debris entrapped in the secondary side fluid stream.
- b) High Cycle Fatigue - OD circumferential cracking normally occurring in the vicinity of the 15th TSP or upper tubesheet secondary face (UTS)

in the open lane & wedge region. The initiating mechanism for high-cycle fatigue is believed to be a combination of surface damage from corrosion, fretting and high crossflow velocities.

- c) Wear - Wear fretting occurs at TSP intersections in tubes near the periphery or outermost rows in the generator. This damage mechanism is caused by flow-induced mechanical vibrations, which are influenced by design parameters, environmental and operating conditions.
- d) Inter-granular Stress Corrosion Cracking (IGSCC) – Tube pull results have confirmed the presence of axially oriented inter-granular stress corrosion cracking. IGSCC has been primarily confirmed at locations from the 007TSP and higher. This problem is not associated with a particular region of the steam generator. Indications are characterized as axial and may display a multiple intermittent response over several inches. IGSCC has been confirmed in the sludge pile on the lower tubesheet and noted at the upper tubesheet and dented TSP locations.
- e) Inside Diameter Inter-granular Attack (ID IGA) – Numerous indications indicative of ID IGA have been reported in the upper tubesheet of Oconee Unit 1, SG B. This mechanism is not believed to be active and is believed to have been initiated as a result of the manufacturing process and unique to SG B of Unit 1.
- f) Primary Water Stress Corrosion Cracking (PWSCC) – PWSCC has been confirmed through tube pulls in the upper tube end (Hot Leg) roll expansion. Indications are generally axially oriented and located in the transition or the expanded region. Plugs and sleeves are also susceptible to this type of damage mechanism.
- g) Inter-granular Attack (IGA) – OD initiated IGA has been detected at the upper spans and within the upper tubesheet crevice, lower tubesheet crevice and first span pit-like IGA.

## 2.4 Results

A number of indications within both generators were given a non-quantifiable (NQI) code in the percent through-wall column. This code was used during the bobbin examinations for indications where an accurate depth determination could not be made.

Additionally, a number of indications within both generators were reported as an Absolute Drift Indication (ADI) in the percent through-wall column. These are indications of degradation that could not be accurately quantified on differential channels.

## **2.5 OTSG A and B results:**

Attachment 2 details the results of the various eddy current examinations performed in OTSG A and OTSG B. A total of four hundred and thirty (430) tubes were removed from service in OTSG "A" and five hundred and sixty (560) tubes in OTSG "B". This total does not include tubes that were de-plugged in upper channel heads. These tubes were removed from service based on the results of the following eddy current examinations. Refer to Data Management Report for results and specific tube numbers for tubes plugged during the outage.

Attachment 1  
DESCRIPTION

<u>CODE</u>	<u>DESCRIPTION</u>
ADI	Absolute Drift Indication
AXI	Axial Indication
FTI	Framatome Technologies
DRS	Distorted Roll Signal
DWI	Dent With Indication
HLRT	Hot Leg Roll Transition
IDI	Inside Diameter Indication
LTP	Lower Tubesheet Primary face
LTS	Lower Tubesheet Secondary face
MAI	Multiple Axial Indication
MCI	Multiple Circumferential Indication
MMI	Mix Mode Indication
MVI	Multiple Volumetric Indication
MRPC	Motorized Rotating Pancake Coil
NDD	No Degradation Detected
NQI	Non-Quantifiable Indication
OD	Outside Diameter
ODI	Outside Diameter Indication
OTSG	Once-Through Steam Generator
PVN	Permeability
PWSCC	Primary Water Stress-Corrosion Cracking
QA	Quality Assurance
RBD	Retest - Bad Data
RIC	Retest - Incomplete
RNC	Retest - Number Check
SAI	Single Axial Indication
SCI	Single Circumferential Indication
SI	Special Interest
SVI	Single Volumetric Indication
TEA	Tube End Anomalies
TSP	Tube Support Plate
TW	Through Wall
TWD	Through Wall Depth
UTP	Upper Tubesheet Primary face
UTS	Upper Tubesheet Secondary face
VOL	Volumetric indication

Attachment 2  
ONS 2 EOC 19 OTSG A and B Eddy Current Results.

Bobbin Examinations

	Steam Generator "A" Tubes Tested: 14,661		Steam Generator "B" Tubes Tested: 14,403	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
TWD > 40%	2	2	1	1
TWD 20-39%	18	18	32	32
TWD < 20%	16	16	34	37
ADI	68	70	65	69
NQI	1739	2603	2086	2975
DWI	24	26	30	33
BLG	0	0	1	1

Bobbin Examinations on de-plugged tubes

	Steam Generator "A" Tubes Tested: 13		Steam Generator "B" Tubes Tested: 25	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
TWD > 40%	0	0	0	0
TWD 20-39%	0	0	0	0
TWD < 20%	0	0	0	0
ADI	0	0	3	3
NQI	13	67	22	36
DWI	0	0	0	0
BLG	0	0	1	1
DNT	2	2	1	1

Lane and Wedge Examinations

	Steam Generator "A" Tubes Tested: 207		Steam Generator "B" Tubes Tested: 201	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
Wear	0	0	0	0
VOL	0	0	0	0
NQI	0	0	0	0
SAI	0	0	0	0
MAI	0	0	0	0
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	0	0	0	0
DNT	0	0	0	0
MVI	0	0	0	0

Sleeve Roll Examinations

	Steam Generator "A" Tubes Tested: 275		Steam Generator "B" Tubes Tested: 251	
	Sleeves With Indications	Number of Indications	Sleeves With Indications	Number of Indications
DRS	0	0	1	1
VOL	4	4	1	2
NQI	0	0	0	0
SAI	0	0	1	1
MAI	0	0	0	0
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	1	1	0	0
MVI	0	0	0	0
PVN	5	5	2	2



Upper Tubesheet Roll Examinations

	<b>Steam Generator "A"</b> <b>Tubes Tested: 14,386</b>		<b>Steam Generator "B"</b> <b>Tubes Tested: 14,152</b>	
	Rolls With Indications	Number of Indications	Rolls With Indications	Number of Indications
VOL	0	0	2	2
NQI	0	0	0	0
SAI	8	8	12	12
MAI	1	1	0	0
SCI	10	10	118	118
MCI	0	0	7	7
MMI	0	0	1	1
SVI	2	2	2	2
MVI	0	0	0	0
PVN	1	1	1	1

Upper Tubesheet Re-Roll Examinations (re-rolls performed during this RFO)

	<b>Steam Generator "A"</b> <b>Tubes Re-Rolled: 0</b>		<b>Steam Generator "B"</b> <b>Tubes Re-Rolled: 38</b>	
	Re-Rolls With Indications	Number of Indications	Re-Rolls With Indications	Number of Indications
VOL	N/A	N/A	0	0
NQI	N/A	N/A	0	0
SAI	N/A	N/A	0	0
MAI	N/A	N/A	0	0
SCI	N/A	N/A	0	0
MCI	N/A	N/A	0	0
MMI	N/A	N/A	0	0
SVI	N/A	N/A	0	0
MVI	N/A	N/A	0	0

Special Interest Examinations

	<b>Steam Generator "A"</b> Tubes Tested: 2182 Locations Tested: 3679		<b>Steam Generator "B"</b> Tubes Tested: 2964 Locations Tested: 4738	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
Wear > 40%	1	1	0	0
Wear 20-39%	53	64	10	10
Wear < 20%	383	457	538	587
VOL	73	79	137	151
SAI	373	1019	486	960
MAI	6	8	5	10
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	22	35	50	60
MVI	0	0	0	0
DNT	137	180	334	558

Special Interest Examinations, de-plugged tubes

	<b>Steam Generator "A"</b> Tubes Tested: 13		<b>Steam Generator "B"</b> Tubes Tested: 25	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
Wear > 40%	1	1	0	0
Wear 20-39%	8	15	2	2
Wear < 20%	10	29	16	23
VOL	0	0	3	3
SAI	1	24	0	0
MAI	0	0	0	0
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	1	1	0	0
MVI	0	0	0	0
DNT	3	3	1	4

Lower Tubesheet Kidney Region Examinations

	Steam Generator "A" Tubes Tested: 2034		Steam Generator "B" Tubes Tested: 2085	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
VOL	2	4	1	1
NQI	0	0	0	0
SAI	1	3	0	0
MAI	0	0	0	0
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	0	0	0	0
MVI	0	0	0	0
PLP	1	1	0	0

Lower Tubesheet Re-Roll Examinations

	Steam Generator "A" Re-Rolls Tested: 2		Steam Generator "B" Re-Rolls Tested: 1	
	Tubes With Indications	Number of Indications	Tubes With Indications	Number of Indications
VOL	0	0	0	0
NQI	0	0	0	0
SAI	0	0	0	0
MAI	0	0	0	0
SCI	0	0	0	0
MCI	0	0	0	0
MMI	0	0	0	0
SVI	0	0	0	0
MVI	0	0	0	0