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February 27, 2007

AEP:NRC:7691

Docket Nos.: 50-315
50-316

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-0001

Donald C. Cook Nuclear Plant Units 1 and 2
STEAM GENERATOR TUBE INSPECTION REPORT

Technical Specification 5.6.7 of Appendix A to the Donald C. Cook Nuclear Plant Unit 1 and Unit 2 Operating Licenses requires that complete results of the steam generator tube inservice inspection be submitted to the Nuclear Regulatory Commission for the inspection that was completed in the previous calendar year. Consistent with this requirement, a copy of the 2006 Steam Generator Tube Inspection Results are attached.

This letter contains no new commitments. Should you have any questions, please contact Ms. Susan D. Simpson, Regulatory Affairs Manager, at (269) 466-2428.

Sincerely,

Joseph N. Jensen
Site Vice President

RBH/rdw

Attachment

A047

c: J. L. Caldwell, NRC Region III
K. D. Curry, AEP Ft. Wayne, w/o attachment
J. T. King, MPSC, w/o attachment
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ATTACHMENT TO AEP:NRC:7691

2006 STEAM GENERATOR TUBE INSERVICE INSPECTION REPORT

Acronyms/Term Definitions

0#C	Cold leg support structure identification number that is, 02C, 03C, etc. 01C is the first support on the cold leg side of the steam generator. 08C is the last support on the cold leg side of the bundle
0#H	Hot leg support structure identification number that is, 02H, 03H, etc. 01H is the first support on the hot leg side of the steam generator. 08H is the last support on the hot leg side of the bundle
% TW	Percent Through-Wall
C-1	Less than 5 percent of the total tubes inspected are degraded tubes and none of the inspected tubes are defective
C-2	One or more tubes, but not more than 1 percent of the total tubes inspected are defective, or between 5 percent and 10 percent of the total tubes inspected are degraded
C-3	More than 10 percent of the total tubes inspected are degraded or more than 1 percent of the inspected tubes are defective
Defective	An imperfection of such severity that it exceeds the plugging limit
Degraded	A tube containing imperfections greater than or equal to 20 percent of the nominal wall thickness caused by degradation
DNG	Ding - Indication code signifying a local reduction of the nominal tube diameter resulting from impact or kinking during steam generator fabrication, transportation, or operation
FB#	U-bend support structure identification number that is, FB1, FB2, etc. FB1 is the first U-bend support on the hot leg side. FB8 is the last U-bend support and is located on the cold leg side of the bundle
Freespan	Region of tubing between support structures
FSH	Freespan History - Indication code referring to a previously reported indication in the freespan area that has been looked up in prior examinations and evaluated with a resulting determination that no significant signal change has occurred

LPI	Loose Part Indication - Identification code referring to an indication of a loose part that has possible wear associated with the identified loose part
MBH	Manufacturing Burnish Mark History - Indication code referring to a previously reported manufacturing burnish mark that has been looked up in prior examinations and evaluated with a resulting determination that no significant signal change has occurred
PLP	Possible Loose Part - Indication code used to identify a potential foreign object on the secondary side of the steam generators
Rxx/Cyy	Identification scheme for the steam generator tube location coordinate corresponding to Row xx and Column yy
SG	Steam Generator
SVI	Single Volumetric Indication – Code used to identify an indication which has axial and circumferential extent and that should be plugged
TSC	Tubesheet cold - Identifier for the top of the tubesheet on the cold leg side
TSH	Tubesheet hot - Identifier for the top of the tubesheet on the hot leg side
TWD	Throughwall Degradation - Indication code referring to a loss of tube material, typically expressed as a percentage of tube wall thickness

Introduction

UNIT 1

During September and October of 2006, SG inservice inspections were conducted on the Unit 1 SGs as detailed below. This inspection constituted the third inservice inspection of the replacement SGs since they were placed in service in 2000. Based upon the favorable results from the 2006 inspection (degradation category C-1) and the provisions of Technical Specification (TS) 5.5.7c, the SGs remain on a maximum inspection interval of 40 calendar months. As such, the next scheduled inservice inspection is in the Fall of 2009.

UNIT 2

Inspections were last conducted on the Unit 2 SGs in October of 2004. Based upon the favorable results of that inspection and in accordance with the provisions of the plant TS as noted above, the Unit 2 SGs continue to be on an inspection interval of 40 calendar months. As such, the next scheduled inservice inspection is in the Fall of 2007.

Unit 1 SG Description

The four replacement Babcock & Wilcox model 51R SGs were initially placed in service in December of 2000.

Each of the replacement SGs contains 3496 thermally treated (TT) alloy 690 tubes with an outside diameter of 0.875 inches and a nominal wall thickness of 0.049 inches. The tubes are arranged in a triangular pitch pattern of 107 columns and 85 rows. The U-bend of all tubes having up to a 12-inch centerline bend radius (rows 1-13) are stress relieved. In addition, the bundle has an increased tube bend radius (i.e., the row 1 bend radius in the original SGs was increased to 4.750 inches in the replacement SGs) to reduce the stress concentration in the U-bend area.

The tube support structure consists of eight stainless steel (SA-240-410S-modified) lattice grid assemblies and four sets of flat bar (also called fan bar) restraints. Each lattice grid consists of interlocking high and low bars that form a lattice pattern to provide lateral restraint in the straight portion of the tubes. The flat bar restraints are made of the same stainless steel material and offer support in the U-bend area.

The tubesheet is a nominal 21.25 inches thick and is made of American Society of Mechanical Engineers SA-508 Class 3a low alloy steel forging material with Inconel cladding on the primary side. All tubes are hydraulically expanded into the tubesheet holes and flush seal welded at the primary face. The expansion includes the entire depth of the tubesheet for both the hot and cold leg sides.

Inspection Scope

SG eddy current inspections were performed in each of the four SGs. The nominal inspection scope consisted of:

- 50.5 percent (1766 tubes) full length with a bobbin coil probe (systematic pattern) in each SG
- 20.5 percent (717 tubes) +/- 3" top of hot leg tubesheet with a motorized rotating pancake coil probe (peripheral tubes and tubes in hard sludge area) in each SG
- Special examinations in areas of interest using rotating coil probes to better characterize select bobbin coil signals (100 total locations within the four SGs)
- Special examinations in areas of interest with bobbin and rotating coil probes to bound possible loose part/foreign object wear/new ding indications (339 tubes in area of interest)
- Full length bobbin coil inspection of two tubes in SG 14 to validate the lack of degradation in response to a tube plugging error
- Visual inspection of all installed mechanical plugs (eight total) for any indication of leakage

Inspection Results

The following table and associated discussion summarizes the pertinent reported indications:

SG Number	Indication Probe							Wear at Structures	
	DNG Bobbin	FSH Bobbin	MBH Bobbin	LPI Bobbin	PLP Bobbin	PLP Rotating	SVI Rotating	TWD < 20%	TWD ≥ 20%
11	0	0	15	0	0	0	0	20	0
12	1	0	25	0	0	0	0	9	0
13	1	0	78	4	1	5	8	2	0
14	5	1	45	0	0	0	0	34	0
Totals	7	1	163	4	1	5	8	65	0

* Note: A tube may have more than one indication/indication code applied.

- DNG - Seven ding signals were reported using a ≥ 2 -volt criterion during the bobbin coil examination. Six of the seven indications were reported previously. Each location was subsequently examined with a rotating coil that confirmed no degradation was present. Visual examinations confirmed no foreign objects were present in the area of the new indication (SG 14 R1/C107).

Summary of DNG Indications

SG Number	Row/Column	Location	Indication Voltage
12	R14/C70	FB4 +5.00	7.81
13	R47/C49	FB4 + 1.78	4.03
14	R1/C107	TSC + 2.48	5.86
14	R49/C57	FB2 + 11.73	2.03
14	R56/C38	FB5 + 14.08	3.05
14	R61/C33	02C + 19.79	2.15
14	R85/C57	TSC + 1.85	4.64

- Freespan Historical Indications (FSH, MBH) – Freespan indications are indications that are not associated with the tubesheet sludge pile region or any support structure. Historical freespan indications such as indication codes FSH/MBH have been: (1) reported in previous inspections; and (2) determined by historical comparison during the current inspection as having insignificant change.

164 total FSH/MBH indications were reported using a ≥ 0.35 -volt criterion during the bobbin coil examination. A 25 percent sample of the indications from each SG was examined with a rotating coil, which confirmed no degradation was present. Due to the general similarity of the indication voltages and for ALARA considerations, this sample did not include indications where a manipulator move would be required to perform the rotating coil inspection.

- LPI/PLP – An LPI occurs when there is identification of a loose part that has possible wear. A PLP indication results when the eddy current probe identifies a potential loose part on the secondary side of the SG.

Foreign object wear may be detected from either the bobbin coil or rotating coil examinations. The initial bobbin coil examination of SG 13 identified four LPIs and one PLP indication all located at the top of the TSC. The five tubes were examined with a rotating coil for additional diagnostics/confirmation and expanded eddy current testing was performed in the area of the bundle where the indications were located. In all, an additional 37 tubes were examined with a bobbin coil and 293 tubes were examined with a rotating coil, as part of the overall foreign object expansion program. These expansions identified three peripheral grouping of indications.

The first grouping (i.e., the four initial LPIs in tubes R79/C35, R78/C34, R77/C35, and R76/C36) were found to have confirmed wear sized at 24 percent, 12 percent, 16 percent, and 3 percent TW, respectively. No foreign objects were found at these locations during the secondary side inspection. These tubes were removed from service (refer to Plugged Tubes section on pages 8 and 9 for additional discussion of the tube repair methodology).

The second grouping contained tubes located around R69/C29, which had the initial PLP indication found during the bobbin coil examination. This area was encompassed in the rotating coil expansion noted above and resulted in three tubes with confirmed wear: R69/C29 – 12 percent; R69/C27 – 13 percent; and R68/C28 – 10 percent. This area was inspected from the secondary side and a foreign object was confirmed at this location. Retrieval attempts were unsuccessful. As a result, the condition was evaluated under our corrective action program and resulted in the three tubes noted above being plugged and stabilized due to the wear and the inability to remove the associated foreign object. In addition, four additional tubes (R67/C27, R70/C28, R71/C29, and R70/C30) in the area were found to have no wear but were preventatively plugged and stabilized to bound the foreign object.

The third group contained tubes R84/C60 and R85/C61, which were identified during the rotating coil expansion as having PLP indications. No tube wear was found on these tubes and secondary side inspections confirmed the presence of only a small sludge rock. As a result, these tubes were left in service.

In all, seven tubes had a total of eight indications of wear (confirmed as SVI by the rotating coil examination) with the largest indication having a depth of 24 percent TW. All indications of

foreign object induced wear, regardless of the depth sizing results, were subsequently plugged. No other LPIs were identified in any other SG.

Tubes with Foreign Object Wear

SG Number	Row/Column	Location	Sizing Information (Max. %TW)
13	R68/C28	TSC + 0.25	10
13	R69/C27	TSC + 0.13	13
13	R69/C29	TSC + 0.53	12
13	R76/C36	TSC + 0.51	3
13	R77/C35	TSC + 0.43	16
13	R78/C34	TSC + 0.21	12
13	R79/C35	TSC + 0.59	24
		TSC + 0.04	24

- Tube Wear (TWD) Mechanical tube wear may occur from interaction between the tube and a support structure (lattice grid/fan bar) or a foreign object as discussed in the previous section.

Each of the four SGs had minor indications of tube wear from support structures as reported by the bobbin coil examination. The largest of these indications was sized at 17 percent and all were left in service. Samples of these indications were examined with a rotating coil to validate that the indications were coincidental with a support structure and did not contain any cracking degradation. The following table summarizes the tube wear indications found in each SG at structures:

Tube Wear from Structures

SG Number	Row/Column	Location	Sizing Information (%TW)
11	R34/C36	04H – 1.45	15
11	R41/C17	04H – 1.71	8
11	R42/C10	03H – 1.66	10
11	R43/C17	04H – 1.71	7
11	R52/C60	FB3 – 1.96	17
11	R57/C51	FB5 + 1.58	5
11	R59/C51	FB5 + 1.69	5
11	R59/C57	FB5 + 0.51	9
11	R66/C66	FB4 – 1.14	5
11	R67/C59	FB4 + 1.05	6

Tube Wear from Structures

SG Number	Row/Column	Location	Sizing Information (%TW)
11	R69/C59	FB6 + 1.12	7
		FB5 + 1.09	7
		FB5 - 1.09	11
		FB4 + 1.12	7
11	R72/C66	FB4 - 1.08	8
11	R77/C57	FB1 + 0.59	11
11	R78/C68	FB4 - 1.08	8
11	R80/C58	FB5 + 1.08	8
		FB4 + 1.15	9
		FB4 - 1.15	10
12	R31/C35	03H - 0.62	11
12	R34/C58	04H - 1.63	6
12	R42/C64	03H + 0.52	8
12	R46/C64	FB3 + 0.82	8
12	R50/C24	04H + 0.43	7
12	R53/C67	03H - 1.68	8
12	R60/C66	03H - 1.74	6
12	R62/C66	03H - 1.70	12
12	R78/C64	FB5 + 1.10	7
13	R52/C44	FB3 + 0.62	12
13	R66/C66	FB4 - 1.16	7
14	R53/C53	FB5 + 0.65	7
		FB4 - 1.74	3
14	R58/C36	07H - 1.67	5
14	R59/C57	FB5 + 1.53	5
14	R62/C60	06H - 1.86	3
14	R63/C57	FB4 + 1.05	3
14	R64/C52	03H - 1.61	3
14	R65/C65	FB4 + 1.12	5
		FB4 - 1.16	3
14	R66/C60	FB3 - 1.21	4
14	R69/C65	FB5 - 1.19	4
		FB4 - 1.27	9
14	R71/C57	FB4 - 0.82	4
14	R73/C57	FB5 + 1.14	5
		FB4 + 0.95	10
14	R74/C52	FB6 + 1.22	4
		FB4 - 1.20	6

Tube Wear from Structures

SG Number	Row/Column	Location	Sizing Information (%TW)
14	R74/C58	FB5 + 1.08	4
		FB4 + 0.97	5
		FB3 + 1.21	6
14	R74/C68	FB4 - 1.08	4
14	R75/C67	FB4 + 1.12	5
14	R76/C66	FB2 + 0.60	3
14	R77/C57	FB5 - 1.03	5
		FB4 + 1.08	6
14	R79/C43	FB4 + 0.97	5
14	R79/C57	FB4 - 1.12	4
14	R80/C50	FB4 - 1.20	5
14	R80/C58	FB5 + 0.99	4
		FB4 - 1.27	3
		FB4 + 1.10	7
14	R80/C60	FB4 + 1.12	5
		FB3 + 1.16	11
		FB3 - 1.36	4

Visual Plug Inspection

No abnormal leakage conditions were identified during the remote visual plug inspection. However, one tube was identified as being mis-plugged from a prior (2002) inspection. This event was evaluated under the plant corrective action system (AR 00803782), which included an extent of condition evaluation for both Donald C. Cook Nuclear Plant units.

No further occurrences of this type were identified. Both tubes were reexamined with a bobbin coil probe and no tube integrity or operational concerns were identified. As part of the corrective actions, the open ends of the impacted tubes (i.e., SG 14, R69/C45 (hot leg) and R69/C63 (cold leg)) were plugged, removing these tubes from service.

Plugged Tubes

No defective tubes (≥ 40 percent TW indication) were identified during the 2006 Unit 1 SG eddy current inspection. However, other tubes had minor indications of foreign object wear, one of which was considered degraded (≥ 20 percent TW indication).

In addition, a foreign object could not be removed from the secondary side of SG 13. As a result of this finding, the following repair methodology was implemented:

- All tubes with foreign object wear were plugged upon detection; if the associated foreign object could not be removed the tube(s) were also stabilized*.
- Select tubes with no tube wear but in the potential migration path of a foreign object that could not be removed were preventatively plugged and stabilized.
- The tube mis-plugging error from 2002 was corrected by plugging the open ends of the two impacted tubes in SG 14.

* Stabilization consists of inserting a steel cable inside the tube to prevent potential future damage from tube severance and then plugging both ends of the associated tube.

Summary of 2006 Repaired Tubes

SG Number	Tube Location (Row/Column)	Repair Method
13	R67/C27	No wear present; however, tube was preventatively plugged and stabilized to bound foreign object that could not be removed.
13	R69/C27	Plugged and stabilized due to tube wear (13%) and inability to remove the associated foreign object.
13	R68/C28	Plugged and stabilized due to tube wear (10%) and inability to remove the associated foreign object.
13	R70/C28	No wear present; however, tube was preventatively plugged and stabilized to bound foreign object that could not be removed.
13	R69/C29	Plugged and stabilized due to tube wear (12%) and inability to remove the associated foreign object.
13	R71/C29	No wear present; however, tube was preventatively plugged and stabilized to bound foreign object that could not be removed.
13	R70/C30	No wear present; however, tube was preventatively plugged and stabilized to bound foreign object that could not be removed.
13	R78/C34	Plugged due to tube wear (12%), no foreign object present.
13	R77/C35	Plugged due to tube wear (16%), no foreign object present.

Summary of 2006 Repaired Tubes

SG Number	Tube Location (Row/Column)	Repair Method
13	R79/C35	Plugged due to tube wear (24%), no foreign object present.
13	R76/C36	Plugged due to tube wear (3%), no foreign object present.
14	R69/C45	Plugged hot leg due to plugging error, cold leg plug installed in 2002.
14	R69/C63	Plugged cold leg due to plugging error, hot leg plug installed in 2002.

Overall SG Tube Plugging Level

SG Number	Number of Tubes/SG	Number of Plugged Tubes (Pre U1C21)	Number of Plugged Tubes (Post U1C21)	As-Left Plugging Percentage
11	3496	2	2	0.06%
12	3496	0	0	0.0%
13	3496	1	12	0.34%
14	3496	1*	2	0.06%
Totals	13,984	4*	16	0.11%

* Refer to AR 00803782 concerning the tube plugging error from U1C18 that was discovered and corrected during U1C21. R69/C45 in SG 14 was found to be plugged on cold leg only, R69/C63 in SG 14 was found to be plugged on hot leg only. Open end of both tubes were plugged during U1C21.

Degradation Category

Based upon the favorable inspection results, which identified only one degraded tube (SG 13, R79/C35) and no defective tubes, the 2006 Unit 1 SGs are considered to be in category C-1 as defined by TS 5.5.7b.