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Donald C. Cook Nuclear Plant Unit 2
2012 STEAM GENERATOR TUBE INSPECTION REPORT

Technical Specification (TS) 5.6.7 of Appendix A, to the Donald C. Cook Nuclear Plant (CNP) Unit 1 and Unit 2 Operating License requires that following the completion of an inspection performed in accordance with TS 5.5.7, Steam Generator (SG) Program, an inspection report be submitted within 180 days after initial entry into Mode 4. CNP Unit 2 entered Mode 4 on April 23, 2012. This report details specific attributes of the inspection in accordance with TS 5.6.7. Consistent with these requirements, Indiana Michigan Power Company, the licensee for CNP Unit 2, is submitting the Unit 2 2012 SG Tube Inspection Report as an enclosure to this letter.

There are no commitments included in this submittal. Should you have any questions, please contact Mr. Michael K. Scarpello, Regulatory Affairs Manager, at (269) 466-2649.

Sincerely,

Joel P. Gebbie
Site Vice President

DMB/kmh

Enclosure: Unit 2 2012 Steam Generator Tube Inspection Report

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Enclosure to AEP-NRC-2012-63

Unit 2 2012 Steam Generator Tube Inspection Report

Introduction

UNIT 2
In April of 2012, steam generator (SG) inservice inspections were conducted on Donald C. Cook Nuclear Plant (CNP) Unit 2. In accordance with the reporting requirements of CNP Technical Specification (TS) 5.6.7, the results of the inspection are provided herein.

Unit 2 SG Description

The four replacement Westinghouse SGs were initially placed in service in March of 1989.

Each SG contains 3,592 thermally treated alloy 690 tubes with an outside diameter of 0.875 inches, and a nominal wall thickness of 0.050 inches. The tubes are arranged in a square pitch pattern of 47 rows and 98 columns. All tubes in the eight innermost rows were thermally stress relieved after bending to reduce residual stress in the U-bend area.

The tube support structures consist of seven 1.12 inch thick support plates with quatrefoil-shaped tube holes, and six anti-vibration bars that are located in the U-bend region of the tubes. There is also a flow distribution baffle (FDB) located between the tubesheet and the first support plate. The FDB is 0.75 inches thick with octafoil-shaped tube holes. The support plates, anti-vibration bars, and the FDB are made of type 405 stainless steel.

The tubesheet is composed of ASME SA-508 Class 2a low alloy steel forging material and is 21.18 inches thick (without cladding). The primary side of the tubesheet is clad with 0.20 inches of Inconel, making the overall nominal tubesheet thickness with cladding, 21.38 inches. Tubes are hydraulically expanded along the full depth of the tubesheet, with the exception of nine tubes. These tubes lack hydraulic expansion in either the hot leg or cold leg tubesheet due to a manufacturing oversight.

At the time of the 2012 inspection, the SGs had accumulated 180.7 effective full power months of operation since their first inservice inspection and 36.7 effective full power months of operation in the second sequential inspection period as defined in CNP TS 5.5.7.d.2. The SGs operated 48.1 effective full power months since they were all last inspected.

As detailed in item "A" which follows, the 100% inspection scope of the 2012 examination fulfilled/exceeded the TS inspection requirements for the first half of the second inspection interval. The next planned inspection of these SGs will occur in fall of 2016.

A. The scope of inspections performed on each SG

Primary Side Eddy Current Inspection Scope

Full length i.e. tube end to tube end examinations were accomplished by:

- Bobbin coil probe examination along the full tube length of approximately 94.6% of the inservice tubes in all four SGs.
- Bobbin coil probe examination of the hot leg and cold leg straight length sections of the inservice row 1 & 2 U-bend tubes (approximately 5.4% of tube total) in all four SGs.
- Rotating pancake coil (RPC) probe examination of the U-bend region of 100% of the inservice row 1 & 2 tubes in all four SGs.

Targeted Examinations (Top of Tubesheet):

- RPC probe examination of the hot leg top of tubesheet region (+/- 3.0") in approximately 20.5% of the tubes in all four SGs.
- RPC probe examination of the cold leg top of tubesheet region (+/- 3.0") in approximately 20.5% of the tubes in all four SGs.

Special Interest Examinations:

- RPC probe examination of selected special interest locations as determined from the results of the bobbin coil examination.

The following table summarizes the above inspections and the number of tubes examined.

EDDY CURRENT EXAMINATION SUMMMARY

Scope	Probe	SG 21 Tube Count	SG 22 Tube Count	SG 23 Tube Count	SG 24 Tube Count
Full Length	Bobbin	3200	3198	3200	3196
Hot Leg Straights	Bobbin	195	193	190	196
Hot Leg Candy Cane	Bobbin	196	196	196	196
Cold Leg Straights	Bobbin	391	389	386	392
Row 1-2 U-bends	RPC	195	193	190	196
Hot Leg Top of Tubesheet	RPC	737	737	737	737
Cold Leg Top of Tubesheet	RPC	737	737	737	737
Select Tube RPC	RPC	2	4	0	0
PLP Bounding Tubes	RPC	9	19	13	7
Hot Leg Special Interest	RPC	36	20	117	44
Cold Leg Special Interest	RPC	9	42	36	10
U-bend Special Interest	RPC	11	15	3	14

Full Length Examinations
Full length examinations were accomplished in three examination plans.

Grouping one consisted of the tubes that were inspected using a bobbin coil probe in a single pass i.e. from the cold leg tube end to hot leg tube end (full length tubes). This inspection included the inservice tubes in rows five through forty-seven.

Grouping two consisted of the tubes that were inspected using a bobbin coil probe in a two pass process i.e. from the hot leg tube end to the uppermost cold leg support (hot leg candy cane tubes) and then from the cold leg tube end to the uppermost cold leg support (portion of the cold leg straight tubes). This inspection included the inservice tubes in rows three and four.

Grouping three consisted of the tubes that were inspected using a combination of hot and cold leg straight sections coupled with a rotating coil inspection of the corresponding U-bend region of the tubing. This inspection included the inservice tubes in rows one and two. This methodology was employed since the tighter radius U-bends in the row one and two tubes makes passage of a qualified bobbin coil probe difficult.

The above inspection plan served to examine nearly* 100% of the inservice tubing full length.

* The U-bend section of tube R2/C21 in SG 22 would not pass a rotating probe without the probe stalling out and emitting bad data. Therefore, this tube was not considered to have had a full examination. As noted in Section "E" this tube was removed from service. This was the only tube of the 14,352 inservice tubes which could not be inspected at full length.

Targeted Examinations (Top of Tubesheet):
737 (20.5%) of the tubes were inspected around the periphery (including the divider lane) of each SG leg at the top of the tubesheet using a rotating coil probe.

A visual examination was used to address the outer most tubes, while rotating coil examinations were performed on the interior, bordering tubes. The primary purpose of this examination was to detect foreign objects or foreign object wear within the outer tube layers of the SG.

Unless otherwise programmed, the examination bounded top of tubesheet +/- 3.0" (in a few cases the extent was modified to obtain data on possible loose part or bulge signals detected during the bobbin coil examination which fell outside the +/- 3.0" range). In the hot leg, the examination also included a sample of the sludge region to detect any temperature driven degradation that could be associated with the sludge area.

Special Interest Examinations
The following special interest rotating coil examinations were performed on reported indications meeting the following criteria:

- 100 % dents/dings indications ≥ 2 volts at structures
- 100 % dents/dings indications ≥ 5 volts
- 20% of all hot leg freespan indications (freespan indication -history (FSH), non-quantifiable signal (NQS), and manufacturing burnish mark - history (MBH) signals > 0.5 volts) not examined in the previous inspection
- All bulge indications
- All bobbin I-codes
- All bobbin percent throughwall calls
- All indications of a lack of hydraulic expansion
- All permeability indications
- Bounding loose part and possible loose part indications

Visual Plug and Channelhead Examination
100% of the installed tube plugs were inspected using a remote camera to confirm plug location and condition. In addition, the remote camera was used to examine the divider plate and tubesheet/channelhead cladding. No abnormal conditions were identified during these examinations.

Secondary Side Inspection Scope
Secondary side inspections (SSI) were performed in all four SGs. The scope included visual inspections of the divider lane and annulus at the top of the tubesheet, select inner bundle passes and foreign object search and retrieval efforts in SG 23. No abnormal conditions were identified during these examinations.

The original SSI scope included two steam drum inspections. However, due to a residual ammonia odor, the steam drum inspections were cancelled because of personnel safety concerns. The ammonia was a result of the SG secondary side chemical cleaning process applied earlier in the outage (see ASCA discussion below). Steam drum inspections performed in two SGs during the previous inspection identified no degradation or abnormal conditions. In addition, no operational experience in this SG design has produced any specific or significant concerns that mandated a steam drum inspection during the 2012 inspection.

In addition to the secondary side inspections, water lancing and an Advanced Scale Conditioning Application (ASCA) were also applied to each SG. The combined efforts of these two processes removed 5,835.5 pounds of material from the four SGs.

B. Active degradation mechanisms found

The only degradation mechanism detected during the inspection was wear. The source of the degradation was support structures (tube support plates and anti-vibration bars). No indications of foreign object related wear were detected during the inspection.

The table below summarizes the number of wear indications recorded in each SG during the inspection for the various mechanisms. The specific indications and their associated percent throughwall (%TW) depth are provided in the response to report item "D".

INDICATION COUNT

Wear Mechanism	SG 21	SG 22	SG 23	SG 24	Totals
Anti-Vibration Bar	0	0	1	0	1
Tube Support Plate	7	0	29	4	40

Anti-Vibration Bar (AVB) Wear

A single AVB wear indication was reported in the SGs. The indication was located in SG 23 on the third AVB (upper most AVB on the hot leg side of the SGs) and had a reported depth of 11%. The indication represents the only AVB related wear indication reported on the Unit 2 SGs since they became operational. The affected tube was left in service.

Tube Support Plate (TSP) Wear

TSP wear showed a mild increase in the number of indications reported in U2C20 over the previous inspection (2007). The 2007 inspection examined a nominal 58% of the tubes and recorded seven total TSP indications with a maximum depth of 12%.

During the 100% examination in 2012, 40 TSP wear indications were reported. As shown in the response to report item "D", the maximum depth of the TSP wear was 14 %TW (same affected tube as reported in 2007 with a 12% indication). None of the associated tubes were removed from service.

C. Nondestructive examination techniques utilized for each degradation mechanism

The table below summarizes the nondestructive examination (NDE) techniques utilized for existing and potential degradation mechanisms.

SUMMARY OF INSPECTION TECHNIQUES

Technique	EPRI ETSS	Demonstrated Applicability - Degradation Mechanism	Extended Applicability *Detection Only*	Depth Sizing Technique
Bobbin	96004.1 (Rev 13)	Wear at supports (tube at AVB, tube at FDB, tube at TSP, or tube at foreign object)	Freespan volumetric wear, loose part wear with part present.	Bobbin /absolute mix amplitude analysis for detection. Sizing for service for structure wear.
Bobbin	27091.2 (Rev 0)	Wear at foreign object, part not present	N/A	Bobbin for detection. Use +Point™ for sizing.
+Point™	10908.4 (Rev.0)	Wear at AVB locations	Tube wear at TSPs/AVBs (confirm not crack-like), loose part wear with part present.	+Point™ / differential mix phase analysis for detection. Sizing for information.
+Point™	21998.1 (Rev 4)	Freespan volumetric	N/A	Single frequency amplitude analysis for detection. Sizing for information.
+Point™	27901.1 – 27907.1 (Rev 0)	Freespan volumetric	N/A	Single frequency amplitude analysis for detection. Sizing for service.
+Point™	21409.1 (Rev 7) I28425 (Rev 3) I28432 (Rev 2)	Axial ODSCC at TSPs, freespan, sludge pile, tubesheet crevice	Axial ODSCC in the presence of AVBs or broached supports.	+Point™ single frequency phase analysis for detection. Sizing for information.
+Point™	21410.1 (Rev 6)	Circ ODSCC at expansion transition	Circumferential ODSCC in expanded tubesheet, sludge pile, tube supports, AVBs, U-bends & denting.	+Point™ single frequency phase analysis for detection. Sizing for information.
+Point™	20510.1 (Rev 7)	Circ PWSCC at expansion transition	N/A	+Point™ single frequency phase analysis for detection. Sizing for information.
+Point™	20511.1 (Rev 8)	Axial PWSCC at expansion transition	N/A	+Point™ single frequency phase analysis for detection. Sizing for information.

AVB Anti-Vibration Bar
EPRI Electric Power Research Institute
ETSS Examination Technique Specification Sheet
FDB Flow Distribution Baffle
ODSCC Outside Diameter Stress Corrosion Cracking
PWSCC Primary Water Stress Corrosion Cracking
TSP Tube Support Plate

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

Indication sizing is summarized below (all indications were axial in nature):

SG	Row	Column	Depth %TW	Location
21	3	47	6	Fifth Hot Leg Support minus 0.61"
21	6	51	13 9	Sixth Hot Leg Support minus 0.61" Fifth Hot Leg Support minus 0.63"
21	6	53	14 7	Sixth Hot Leg Support minus 0.66" Fifth Hot Leg Support minus 0.63"
21	6	54	7 7	Fifth Hot Leg Support minus 0.59" Fourth Hot Leg Support minus 0.61"
23	1	45	7	Fifth Hot Leg Support minus 0.63"
23	1	47	5	Fifth Hot Leg Support minus 0.63"
23	1	54	8	Sixth Hot Leg Support minus 0.65"
23	3	57	7 4	Sixth Hot Leg Support minus 0.67" Fifth Hot Leg Support minus 0.65"
23	4	55	7	Sixth Hot Leg Support minus 0.70"
23	4	56	9 5	Sixth Hot Leg Support minus 0.60" Fifth Hot Leg Support minus 0.65"
23	4	59	6	Sixth Hot Leg Support minus 0.70"
23	5	50	4 5	Sixth Hot Leg Support minus 0.65" Fifth Hot Leg Support minus 0.63"
23	5	51	5 5	Fifth Hot Leg Support minus 0.65" Fourth Hot Leg Support minus 0.63"
23	5	89	8	Fifth Hot Leg Support minus 0.63"
23	6	42	6	Fifth Hot Leg Support minus 0.65"
23	6	50	6	Sixth Cold Leg Support minus 0.63"
23	6	53	5	Sixth Hot Leg Support minus 0.71"
23	6	82	5	Fourth Hot Leg Support minus 0.63"
23	7	46	6 7	Seventh Hot Leg Support minus 0.61" Sixth Hot Leg Support minus 0.68"
23	7	49	6	Sixth Cold Leg Support minus 0.60"
23	7	51	7	Sixth Hot Leg Support minus 0.65"
23	7	55	6	Fifth Hot Leg Support minus 0.67"
23	12	54	6	Seventh Hot Leg Support minus 0.65"
23	17	45	6	Third Hot Leg Support minus 0.61"
23	33	32	7	First Hot Leg Support minus 0.55"
23	35	58	5	Seventh Cold Leg Support minus 0.57"
23	46	53	7	Seventh Hot Leg Support minus 0.72"
23	46	59	6	Seventh Hot Leg Support minus 0.74"
23	47	50	11	Third Anti Vibration Bar minus 0.22"
24	2	43	9	Sixth Hot Leg Support minus 0.70"
24	2	47	7	Sixth Hot Leg Support minus 0.70"
24	7	46	7	Sixth Hot Leg Support minus 0.68"
24	7	54	9	Sixth Hot Leg Support minus 0.68"

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

Only one tube was removed from service. Tube R2/C21 in SG 22 was plugged, not because of degradation but because of inspectability issues. The subject low row tight radius tube was historically difficult to examine in the U-bend area. Similarly in U2C20, the U-bend area again presented problems. While the straight leg sections were successfully examined, the rotating coil used in the U-bend examination would not rotate smoothly through a section of the tubing. Variations in probe body diameter, rotation speed acquisition direction and acquisition leg were applied with no success. As a result, a full length examination of the tube could not be credited. Condition monitoring was successfully demonstrated based upon an engineering analysis. However, the tube was removed from service to prevent occurrence of a similar problem.

F. Total number and percentage of tubes plugged to date

The following table identifies the total number/percentage of tubes plugged for each SG to date:

SG Identifier	Number of Tubes/SG	Number of Plugged Tubes	Plugging Percentage (%)
SG 21	3,592	1	0.028
SG 22	3,592	6	0.167
SG 23	3,592	6	0.167
SG 24	3,592	4	0.111
Total	14,368	17	0.118

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

Evaluation of the indications found during the 2012 inspection indicated that the condition monitoring requirements for structural and leakage integrity, as specified in TS 5.5.7, were satisfied.

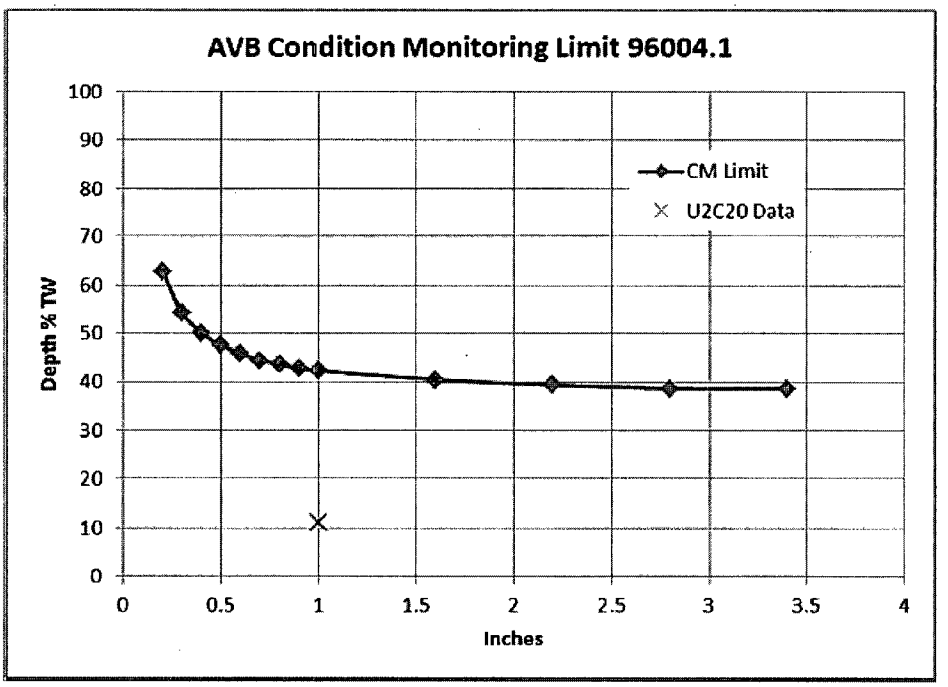
As mentioned previously, a portion of the tube R2/C21 in SG 22 could not be examined. Therefore, an engineering analysis, as permitted by SGMP-IG-10-01, Interim Guidance Regarding SG Management Program: Steam Generator Integrity Assessment Guidelines, Revision 3 was performed on tube R2/C21 to confirm condition monitoring for that specific tube.

Degradation specific condition monitoring limits were applied to the indications in the remaining tubes for each degradation mode (anti-vibration and tube support wear). As shown in the figures below, no degradation exceeded the technical specification repair limit of 40 %TW or the condition monitoring limits.

No detectable primary-to secondary leakage was identified during the previous cycle or is postulated to occur during current operating interval based upon the levels of degradation present in the SGs.

The inspection found no indications that met the criteria for in-situ pressure testing and no tubes were required to be pulled.

AVERAGE DEPTH ANTI-VIBRATION BAR WEAR CONDITION MONITORING LIMIT



AVERAGE DEPTH TUBE SUPPORT PLATE WEAR CONDITION MONITORING LIMIT