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2CAN090601

September 19, 2006

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Response to Request for Additional Information on ANO-2 Steam Generator Tube Inservice Inspection Report
Arkansas Nuclear One – Unit 2
Docket No. 50-368
License No. NPF-6

REFERENCE: 1 Entergy letter dated March 16, 2006, *Steam Generator Tube Inservice Inspection Report* (2CAN030601)

Dear Sir or Madam:

Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specification 6.6.7.b requires that the complete results of ANO-2 steam generator (SG) tubing in-service inspections (ISI) be reported within 12 months following the completion of the inspection. Reference 1 provided the SG Tubing In-service Inspection Report which provided the results from ANO-2's scheduled refueling outage (2R17) inspection.

During NRC review of the ANO-2 SG Tube ISI report, the staff requested additional information to support their review. The attachment to this submittal provides the responses to the NRC requested information.

This submittal contains no commitments. Should you have any questions regarding this report, please contact Steve A. Bennett of my staff at (479) 858-4626.

Sincerely,

DEJ/sab

Attachment: Response to NRC Request for Additional Information on Steam Generator Tubing Inservice Inspection Report

A047

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Attachment

2CAN090601

Arkansas Nuclear One, Unit 2

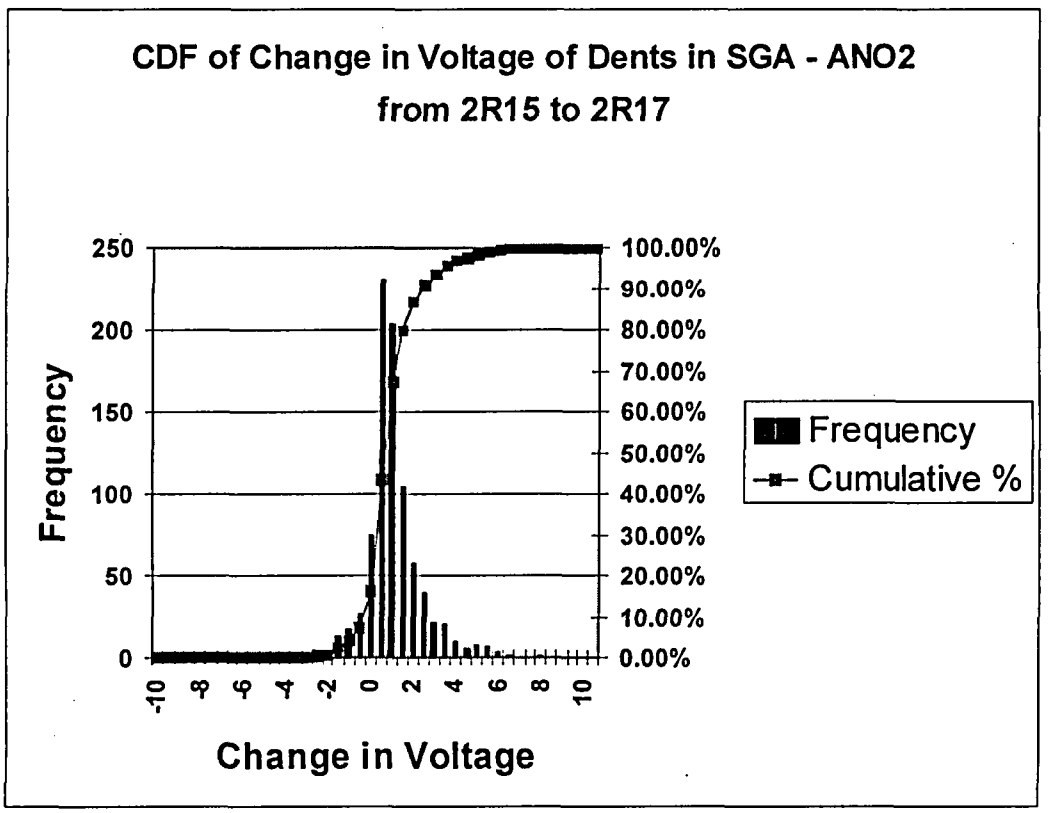
Response to NRC Request for Additional Information on Steam Generator Tubing Inservice Inspection Report

Response to NRC Request for Additional Information on Steam Generator Tubing Inservice Inspection Report

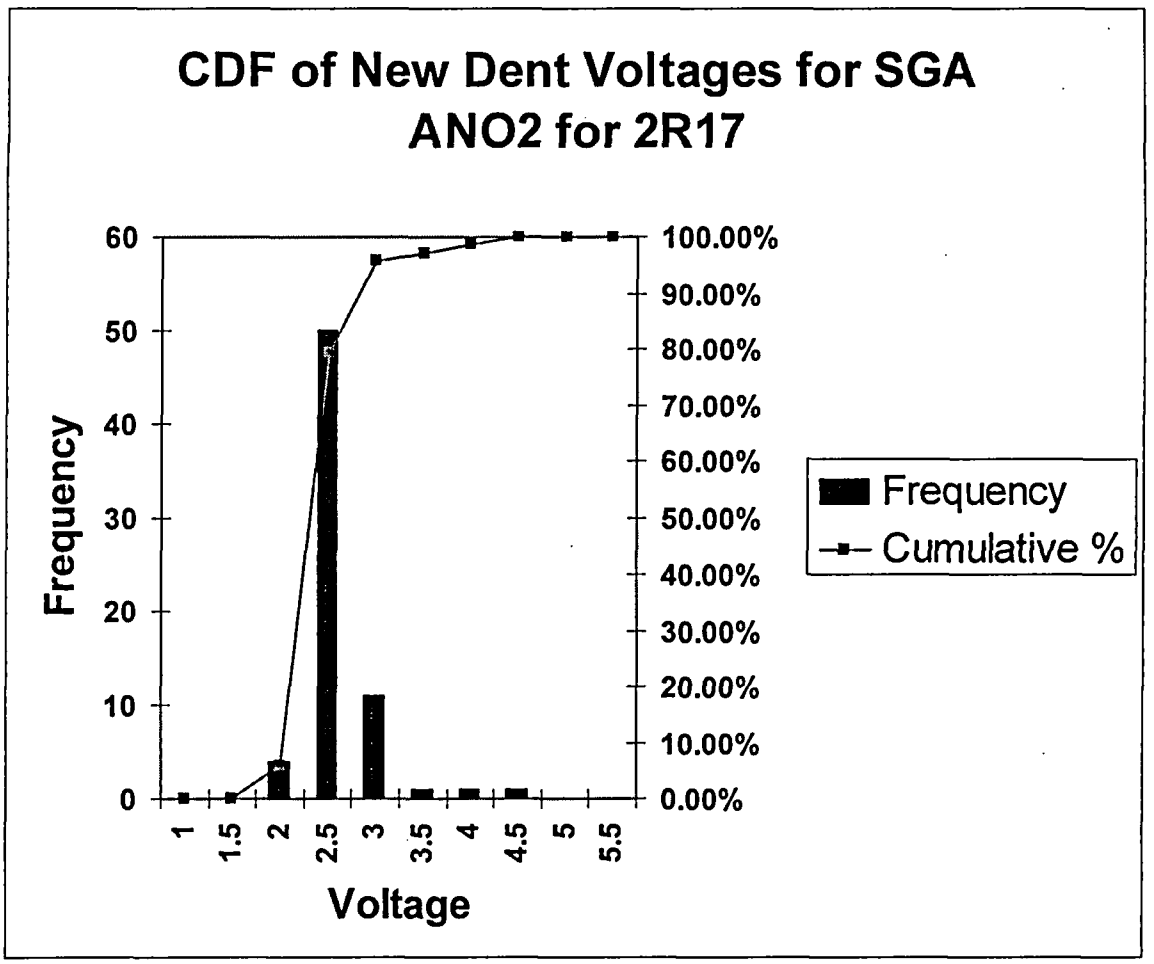
NRC RAI 1 *Discuss the scope and results of any dent and ding exams performed during the Cycle 17 steam generator (SG) tube inservice inspections. Please discuss whether any rotating probe exams were done and include the number of dents/dings in each SG. In addition, discuss whether there were any new dents/dings identified (if so, causal mechanism), whether there were changes in the dent/ding signals (if so, causal mechanism), whether any "anomalous" dent signals were identified, and the inspection criteria (e.g., greater than or equal to 2-volts).*

ANO-2 Response:

Dents/dings are identified with the bobbin campaign. The scope from 2R17 was 54% of the tube population. A review was performed to compare the dents/dings from 2R15 (spring 2002) to 2R17 (spring 2005). 2R15 was the first inservice inspection (ISI) after one cycle of operation and included 100% of the tubing. Both generator results were consistent with steam generator A (SGA) having the largest population of dents. Therefore, for this report, SGA data is being reported. A cumulative distribution factor (CDF) of the change in voltage for dents identified in both outages was performed. The mean change was approximately 0.6 volts which is considered an insignificant change based on the technique. This is presented in the graph below:



A review was performed of newly identified dents in 2R17. These were determined to be a function of the threshold limit of 2.0 volts as the vast majority of the newly reported dents were at this value. From the graph below, the majority of the dents remain at or near the detection threshold. Based on this data, the relative condition of the dents in the ANO-2 steam generators is not changing.



NRC RAI 2 *Please confirm that no other service induced indications other than wear at structures and loose parts were identified during the Cycle 17 SG tube inservice inspections.*

ANO-2 Response:

No other service induced indications were identified during 2R17other than wear at structures and due to loose parts.

NRC RAI 3 *Table 3.2.1 and Table 3.2.2 in the 12-month SG tube inservice inspection report, provided the indications identified in SGA and SGB for Cycle 17. Table 3.3.1 and Table 3.3.2 of the same report provided the tubes plugged in SGA and SGB during Cycle 17. There were four tubes with loose part wear indications in SGA and four tubes with loose part wear indications in SGB that were not plugged. Please discuss the basis for determining which tubes with a wear indication attributed to a loose part were plugged. In addition, discuss whether the loose parts were removed from the SGs. If the loose parts were removed, discuss the nature of the parts. If the loose parts were not removed, please discuss whether analyses were performed to ensure that tube integrity would be maintained until the next inspection of these tubes.*

Several tubes with possible loose part (PLP) indications were plugged. Please confirm that all tubes with PLP indications were plugged. If they were not, discuss the rationale used to determine which PLP indications would be plugged.

For the tubes that were plugged, discuss whether they were stabilized.

ANO-2 Response:

Steam Generator Tubes Not Plugged

SGA

Tubes R142C119, R144C119, R146C113 and R146C115 involved a wire loose part which was removed. These tubes were not plugged since the percent throughwall indications was less than the 40% tube repair limit (including projected wear through the next scheduled inspection).

2R17 SGA Tubes Having a Percent Throughwall Indication

Item No.	Row	Column	Percent Through Wall	Location	Mechanism
1	59	60	13	A07	AVB Wear
2	62	13	14	A05	AVB Wear
3	63	46	11	A14	AVB Wear
4	70	169	100	TSH	Loose Part Wear
5	70	169	86	TSH	Loose Part Wear
6	71	170	57	TSH	Loose Part Wear
7	72	169	46	TSH	Loose Part Wear
8	72	169	54	TSH	Loose Part Wear
9	74	15	16	A18	AVB Wear
10	87	108	17	A09	AVB Wear
11	119	76	19	A09	AVB Wear
12	121	86	21	A09	AVB Wear
13	135	78	16	TSC	Loose Part Wear
14	135	102	15	A09	AVB Wear
15	135	102	14	A15	AVB Wear
16	142	119	5	TSH	Loose Part Wear
17	142	119	10	TSH	Loose Part Wear
18	144	119	7	TSH	Loose Part Wear
19	146	113	10	TSH	Loose Part Wear
20	146	115	4	TSH	Loose Part Wear
21	146	115	6	TSH	Loose Part Wear

SGA Plugged Tubes

	Row	Column	Indication	Location
1	70	169	SVI	TSH +0.25
2	72	169	SVI	TSH +0.87
3	71	170	SVI	TSH +0.92
4	135	78	SVI	TSH +0.04

SGB:

Tubes R100C25 and R102C25 had a wear scar from a loose part that was removed in 2R15. Since the depth was less than 40%, the tube was left in service.

Tube R124C129 was visually inspected. The part was no longer present and the depth was less than 40% so the tube was left in service.

Tube R138C119 was visually inspected. The part was no longer present and the depth was less than 40% so the tube was left in service.

2R17 SGB Tubes Having a Percent Throughwall Indication

Item No.	Row	Column	Percent Through Wall	Location	Mechanism
1	52	109	7	A07	AVB Wear
2	100	25	16	TSC	Loose Part Wear
3	102	25	4	TSC	Loose Part Wear
4	109	92	26	A11	AVB Wear
5	112	149	10	A12	AVB Wear
6	112	149	14	A18	AVB Wear
7	113	92	15	A14	AVB Wear
8	113	92	7	A17	AVB Wear
9	116	99	14	A09	AVB Wear
10	116	99	13	A12	AVB Wear
11	124	129	11	TSH	Loose Part Wear
12	125	92	14	A15	AVB Wear
13	133	48	13	A13	AVB Wear
14	133	48	17	A15	AVB Wear
15	133	48	8	A17	AVB Wear
16	133	48	5	A19	AVB Wear
17	138	119	8	TSH	Loose Part Wear
18	138	119	10	TSH	Loose Part Wear
19	139	120	43	TSH	Loose Part Wear

SGB Plugged Tubes

	Row	Column	Indication	Location
1*	6	97	PLP	TSC +0.19
2*	5	98	PLP	TSC +0.13
3*	7	98	PLP	TSC +0.15
4*	20	173	PLP	TSC +0.11
5*	21	172	PLP	TSC +0.13
6*	22	173	PLP	TSC +0.09
7	139	120	SVI	TSC +0.10

*- These tubes did not show wear, but were preventively plugged due to a potential unconfirmed loose part.

Loose Parts Removed:

SGA

Tubes involved	Loose Part
R70C169 (leaker), R71C170, R72C169	Carbon steel mass ~ 1.25" x 0.5" (fabrication remnant)
R142C119, R144C119, R146C113, R146C115	Weld Wire (fabrication)
R2C89, R3C90#	Stainless steel screw
R147C88, R149C88, R148C89#	Carbon Steel fragment (fabrication)

- The loose part at these tubes did not show wear indications

SGB

Tubes involved	Loose Part
R146C111, R145C112, R147C112	Machine winding

Loose Parts Not Removed:

SGA

Tubes involved	Loose Part
R135C78	Piece of metal wrapped around base of tube – plug & stabilized
R110C137	Small wire – not retrievable – no wear

SGB

Tubes involved	Loose Part
R133C86	Small wire (needle like)- not retrievable – no wear
R142C111	Small wire (needle like)- not retrievable – no wear
R21C172, R20C173, R22C173	Small wire visible on 3 tubes – plug and stabilized
R6C97, R5C98, R7C98	Unknown part on 3 tubes – plug and stabilize

Evaluation Criteria for Dispositioning Potential Loose Parts

There were several PLPs that were evaluated and dispositioned. The following is the criteria used based on eddy current results, visual inspections and local velocities:

1. Identification of PLP by eddy current testing (ECT). This included full length bobbin and plus point testing at the top of the tube sheet.

2. Evaluation of affected area visually using remote camera equipment. Where practical, an attempt was made to perform a visual inspection. If a loose part was confirmed visually, an attempt was made to retrieve the part. To disposition any PLPs that could not be visually examined or retrieved, further evaluation was performed using the following criteria:

   Wear present: If tube wear was identified and it could not be confirmed that a PLP was not present (by removal or visual confirmation), the affected tube(s) were plugged and stabilized.

   No wear present: Where there was no wear present, the PLP indication was further dispositioned considering the following:

   Visual confirmation (where practical)

   - If observed, depending on size and considering the other factors below, it was judged acceptable or plugging and/or stabilizing was performed.

   - If it is verified that a loose part is no longer present, no further action required.

   - If the area is not inspectible, additional evaluation was performed as discussed below.

   ECT characterization

   - Using the low frequency channel on the 0.115 pancake coil, data was reviewed for distortions, location of the indication, voltage, and adjacent signals

   - Using the plus point coil, areas identified with the 0.115 pancake were analyzed for the presence of wear indications.

   Fluid flow was categorized as either high or low. Any PLP in a "high" flow area was further evaluated for leaving as-is.

   - If the visual inspection determines that there is no part at the tube then no further action is warranted.

   - If a part is found and there is no sign of active wear on the tube and it can be concluded that the PLP is very small (e.g., the projected flow area is less than 10% of the part that caused the leak), no additional action is required.

- If both of those criteria cannot be met, then the PLP should either be removed or the affected tube(s) is to be plugged and stabilized. A subjective dividing line of 6.5 ft/sec has been established as the cutoff between high flow and low flow areas. Assuming the fluid density is approximately the same; the wear rate of a part would be proportional to the square of the velocity.

  Example: The wear rate for a given part would be a factor of 3.0 lower in a 6.5 ft/sec flow field than in an 11.3 ft/sec flow field. Since the density decreases as the fluid enters the tube bundle, the 3.0 factor will increase farther into the tube bundle and is considered a conservative threshold. If it is assumed that the loose part wore through R70/C169 in one cycle that same loose part would take three cycles to wear through a tube in a 6.5 ft/sec flow field. Even though it cannot be determined how long a given part will wear through the tube, the 3.0 factor provides a relative basis for determining tube degradation.

Plugging and Stabilizing

The following table lists the tubes that were plugged and whether they included a stabilizer. The indications identified as PLPs are for those tubes where indications were evaluated but could not be visually verified to be free of a PLP or where the part was removed. These tubes were conservatively removed from service. The breached tube (leaker) was also stabilized.

ANO SG Tubes Plugged and Stabilized

Gen	Row	Column	Indication	Plug	Stabilizer
A	70	169	SVI	Yes	Yes
A	72	169	SVI	Yes	No[1]
A	71	170	SVI	Yes	No[1]
A	135	78	SVI	Yes	Yes
B	6	97	PLP	Yes	Yes
B	5	98	PLP	Yes	Yes
B	7	98	PLP	Yes	Yes
B	20	173	PLP	Yes	Yes
B	21	172	PLP	Yes	Yes
B	22	173	PLP	Yes	Yes
B	139	120	SVI	Yes	No[2]

1 – Tube not stabilized since PLP was removed
2 – No PLP, but greater than 40% throughwall

NRC RAI 4. *Your report provided information about flaws in specific tubes and at specific locations within a tube. In order for the U.S. Nuclear Regulatory Commission staff to better understand where your indications are being detected and for future reference, please provide the following information regarding the design of your replacement SGs: tube manufacturer, a tubesheet map, the tubesheet thickness (with and without the clad), the tube support plate thickness, the smallest U-bend radius and corresponding row, and a description of the U-bend support system, including the shape and thickness, and the tubing supported by the various supports. In addition, discuss whether you have a flow distribution baffle to distribute flow at the top of the tubesheet, including the thickness and hole shape.*

ANO-2 Response:

General design details of the ANO-2 replacement steam generators are contained in Section 5.5.2 of the ANO-2 Safety Analysis Report (SAR). SAR Figure 5.5-7 provides a cutaway depiction of the ANO-2 replacement SGs. The following are specific details of the replacement SGs:

Design of replacement SG	Westinghouse Delta 109
Tube Manufacturer	Sandvik
SG Tubes	10637 per SG Alloy 690TT 0.688" nom OD 0.04" nom wall thickness
Tubesheet Map	See Figure 1 (attached)
Tubesheet Thickness	31.13" for tubesheet forging 0.43" primary clad thickness
Tube Support Plate Thickness	1.115 inches
Smallest U-bend Radius	3.250 inches (Row 1)
Flow Distribution Baffle	ANO-2 does not have a baffle
U-bend Support System:	Anti-Vibration Bars

The SG tubes are supported on the secondary side by eight (8) tube support plates (TSPs). The TSP material is Type 405 stainless steel. The TSPs have trifoil shaped holes produced by broaching to reduce tube dryout and chemical concentration in the regions where the tubes pass through the TSPs.

Five (5) sets of staggered anti-vibration bars (AVBs) are installed to provide support for the U-bends of the tubes. The AVB assemblies are installed to staggering depths to provide enhanced flow within the central region of the tube bundle. Each AVB assembly consists of a "V" shaped bar of Type 405 SS and two (2) thermally treated (TT) Alloy 690 end caps. Each end of the AVB assemblies is secured to the

U-bend peripheral Alloy 690TT retaining rings by welding. Four (4) chrome plated Alloy 690TT U-shaped retainer bars are installed between several of the peripheral U-tubes. These retainer bars provide support to the AVB assemblies during seismic and postulated steam line break loads.

Arkansas Nuclear One Unit Two Delta 109

Arkansas Nuclear 2R17 ANO2 D109

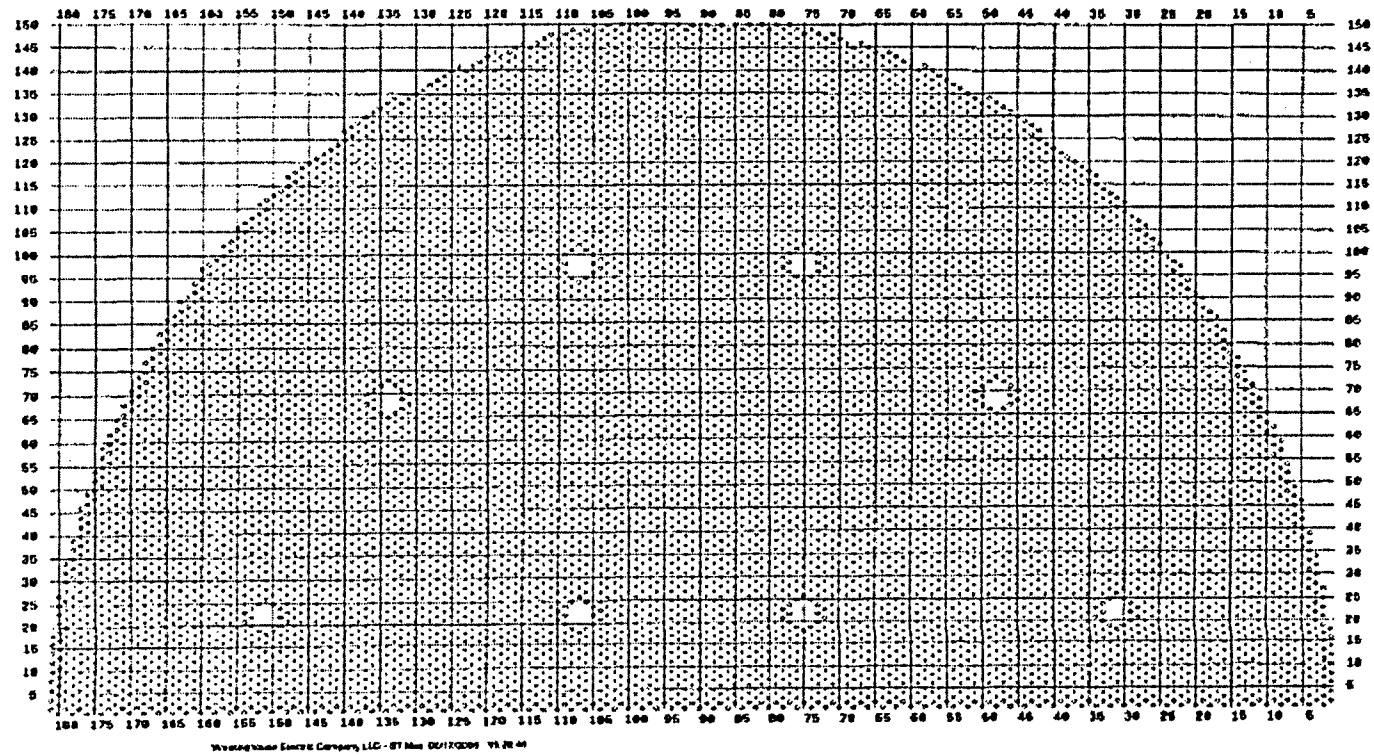


Figure 1
ANO-2 Replacement Steam Generator Tubesheet