Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-4704

Stephenie L. Pyle
Manager, Regulatory Assurance
Arkansas Nuclear One

2CAN021502

February 23, 2015

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

SUBJECT: Anti-Vibration Bar Positioning and Sludge Evaluation Information Concerning the Spring 2014 Steam Generator Inspections
Arkansas Nuclear One – Unit 2
Docket No. 50-368
License No. NPF-6

REFERENCES:

1. Entergy letter to NRC, "Steam Generator Tube Inspection Report - 2R23," dated August 18, 2014 (2CAN081404) (ML14230A898)

2. Email from Andrea George (NRC) to David B. Bice (Entergy), "Request for Additional Information for Spring 2014 Steam Generator Tube Inspection Report for ANO, Unit 2 (MF4653)," dated November 19, 2014 (ML14323A206)

3. Entergy letter to NRC, "Response to Request for Additional Information Concerning the Spring 2014 Steam Generator Inspections," dated January 12, 2015 (2CAN011502) (ML15014A040)

Dear Sir or Madam:

Entergy Operations, Inc. (Entergy) inspected the Arkansas Nuclear One, Unit 2 (ANO-2) steam generator tubes during the Spring 2014 refueling outage (2R23) in accordance with ANO-2 Technical Specification (TS) 6.5.9. ANO-2 TS 6.6.7 requires a written report of the results of the inspection be submitted to the NRC. The required report was submitted via Reference 1.

In the course of the NRC's review of the report, it was determined that additional information was required to complete the evaluation. The NRC requested the information in Reference 2. Reference 3 provided Entergy's response to the requested information with the exception of the Anti-Vibration Bar (AVB) positioning and the sludge evaluations. The required information was not available at the time of the Reference 3 submittal. Entergy committed to provide information for both the AVB positioning and sludge evaluation. The purpose of this submittal is to fulfill that commitment and provide the remaining requested information. Please see the attachment to this letter.

A001
NRR

This correspondence contains no new commitment.

Should you have any questions regarding this submittal, please contact me.

Sincerely,

SLP/rwc

Attachment: Anti-Vibration Bar Positioning and Deposit Loading Information Based on the Spring 2014 Steam Generator Inspections

cc: Mr. Marc L. Dapas
Regional Administrator
U. S. Nuclear Regulatory Commission, Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Ms. Andrea E. George
MS O-8B1
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

ATTACHMENT TO

2CAN021502

ANTI-VIBRATION BAR POSITIONING AND DEPOSIT LOADING INFORMATION BASED ON THE SPRING 2014 STEAM GENERATOR INSPECTIONS

ANTI-VIBRATION BAR POSITIONING AND DEPOSIT LOADING INFORMATION BASED ON THE SPRING 2014 STEAM GENERATOR INSPECTIONS

Entergy Operations, Inc. (Entergy) committed to provide additional information when it became available associated with the Arkansas Nuclear One – Unit Two (ANO-2) Steam Generators (SGs). The information was associated with two issues:

1. Anti-Vibration Bar (AVB) Positioning
2. Deposit Loading on the Top Support Plate

These are discussed individually below:

1. Anti-Vibration Bar (AVB) Positioning

During the most recent inspection (2R23) in 2014, a 100% bobbin inspection was performed full length of the SG tubes. As part of that testing, auto analysis was performed to locate and map out the AVB. This was due to operating experience where SGs were found to not be fabricated as designed and thus some tubes were left unsupported resulting in failures.

ANO-2 AVB Design

The design of the ANO-2 SG AVB assemblies is unique with the following characteristics:

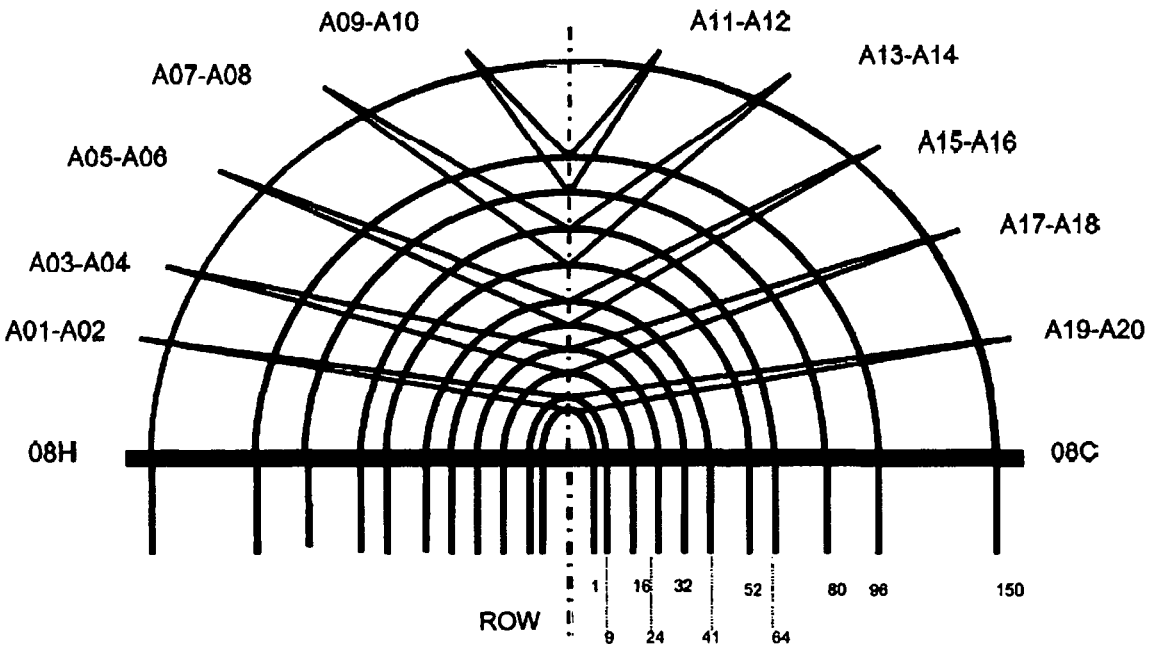
- There are 10 AVB assemblies labeled A01-A20, A02-A19 through A10-A11 as shown in Figure 1.
- Pairs of AVB assemblies such as A01-A20 / A02-A19 originate from the same point at the outer periphery of the tube bundle as shown in Figure 1.
- AVB angle varies from column to column for "odd-even" AVB assemblies (A01-A20, A03-A18, etc.) while it is constant for "even-odd" AVB assemblies (A02-A19, A04-A17, etc.). A01-A20 intersects typically tubes in row 1 with the angle increasing in low columns and measuring 121.9° between columns 1 and 2, 125.3° between columns 2 and 3, 130.8° between columns 4 and 5, 134° between columns 6 and 7 and so on. The same AVB assembly is symmetrical in the high column half with the angle decreasing. The angle of A02-A19 assembly is held constant throughout the SG at 149.3°.
- With the exception of the periphery, the AVBs that make the same "set" (A01-A10 and A02-A19, A03-A18 and A04-A17, etc.) are installed intermittently. For example, A01-A20 is installed between columns 6 - 7, 8 - 9, 10 - 11, while A2-A19 is installed between columns 7 – 8, 9 – 10, 11 – 12, etc.
- AVB assembly center line intersects tube center line typically at rows 1, 9, 16, 24, 32, 41, 52, 64, 80 and 96.

- AVB radius at the tip intrados is constant and measures 1.50".

This design results in AVBs being very close to each other in certain areas of the U-bend making AVB locating and labeling challenging.

Figure 1

AVB Assemblies



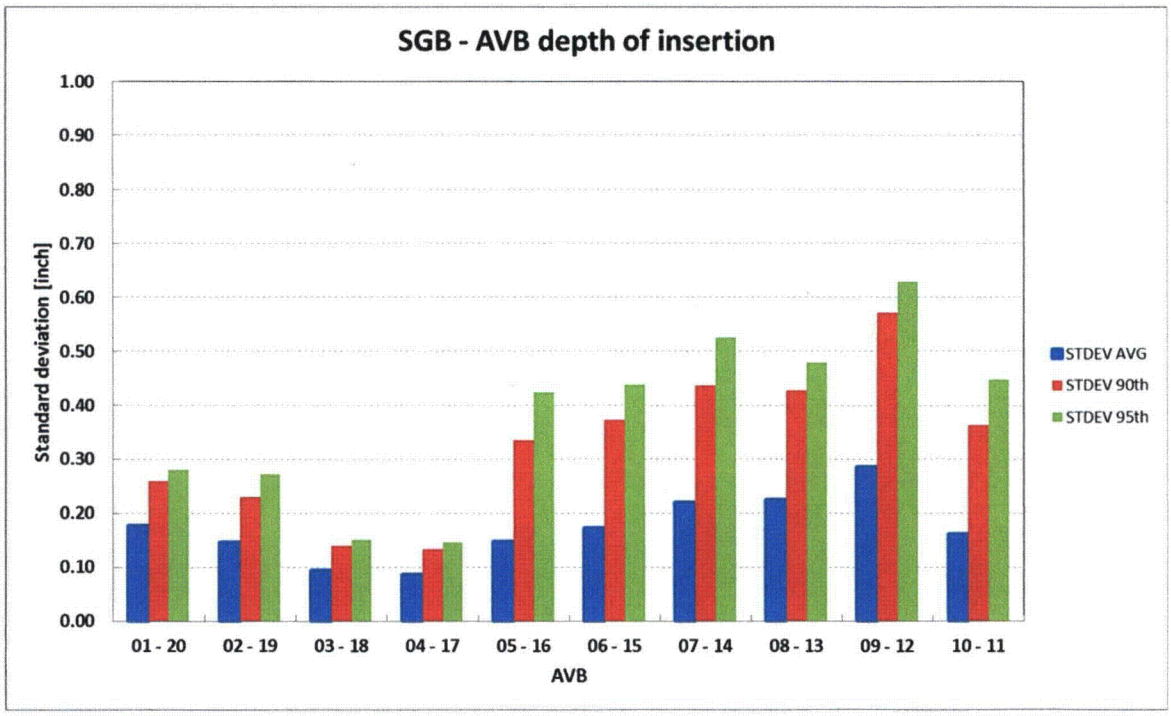
Eddy current was used to identify where the AVBs intersected the tubes allowing the full depth of penetration to be identified. The following is a summary of the results:

- All anti-vibration bars are installed.
- The depth of insertion for most of the bars is in accordance with the design information relative to the typical row where the AVB should intersect the tube. Minor differences between columns were noted to exist when locating a specific bar. Overall, the AVB bundle is uniform. It does not show any particular unexpected pattern and it is similar or better when compared with other SGs analyzed.

There are AVB assemblies that do not reach typical depth of insertion. The penetration depths are associated with the low row tubes which experience minimal flow velocities. Therefore there is little risk of a vibrational issue. In Figure 2 below, the depth of insertion for the various AVBs

is listed for Steam Generator B (SGB). SGB was bounding for Steam Generator A (SGA). As identified in the figure, the largest 95th percentile value was slightly higher than 0.6 inches of actual versus design depth.

Figure 2



Regular eddy current examination provides bobbin data that is always evaluated for the presence of AVB wear such that if any wear will result due to less than optimal support, it will be detected and reported.

2. Deposit Loading on the Top Support Plate

Blockage of the support plates from buildup of deposit, especially at the top support plate (TSP), is a concern for SG tube integrity. As identified in NRC Information Notice 2007-37 (ML072910750), between 2004 and 2006 there were three primary-to-secondary leaks at the Cruas Nuclear Plant, a multi-unit site in France, all of which were a result of circumferential cracks in the tubes at the upper most support plate. The cracks were determined to be caused by high cycle fatigue as a result of flow induced vibration, and the tubes became susceptible to vibration and fatigue as a result of the buildup of deposits on the secondary side of the SG. The deposits had blocked water/steam flow through the broached holes in the TSP forcing more water/steam into the center of the bundle where these tubes were located.

ANO-2 has performed sludge lancing in the past, but the amount of material removed did not support a detailed analysis. In addition, the sludge deposited in the upper bundle is typically different than that deposited on the tube sheet.

A review of the eddy current data identified the various alterations in the eddy current signal response that confirm the presence of open tube surface deposition and the presence of deposition within the top most TSP. As part of the process, all of the eddy current test (ECT) data from the 2014 SG inspection (2R23) and the 2009 SG inspection (2R20) was reviewed.

After reviewing the ECT data from both the 2R20 and 2R23 SG inspections, the following statements were determined relevant regarding the blockage of the TSP:

- Deposit is accumulating within the TSP, primarily on the hot leg side.
- Deposit is continuing to increase within the TSP, in both quantities of deposit and percentage of the support affected.
- Based on industry Operating Experience from AREVA deposit mapping analyses at other utilities, deposit will continue to increase adjacent to and within the TSPs at ANO-2.

Figure 3 plots the percentage of broached holes per support plate for SGA which have deposition identified by the "CentRef" measurement (i.e. contained within the support). As seen in the figure, greater than 90% of the hot leg side and 25% of the cold leg side of the TSP have deposit identified within the support. The one inch deposit measurements immediately above and immediately below the support resulted in similar distributions.

Figure 4 provides a qualitative look at the deposits in SGA. Quantitative values would require development of a specific sludge standard so voltage can be related to sludge depth.

Management of the deposit buildup is being addressed in accordance with EPRI Integrity Assessment guidelines for maintenance of SG secondary side integrity.

Figure 3

SGA 2R23 Tube Depositions at TSPs – "CentRef"

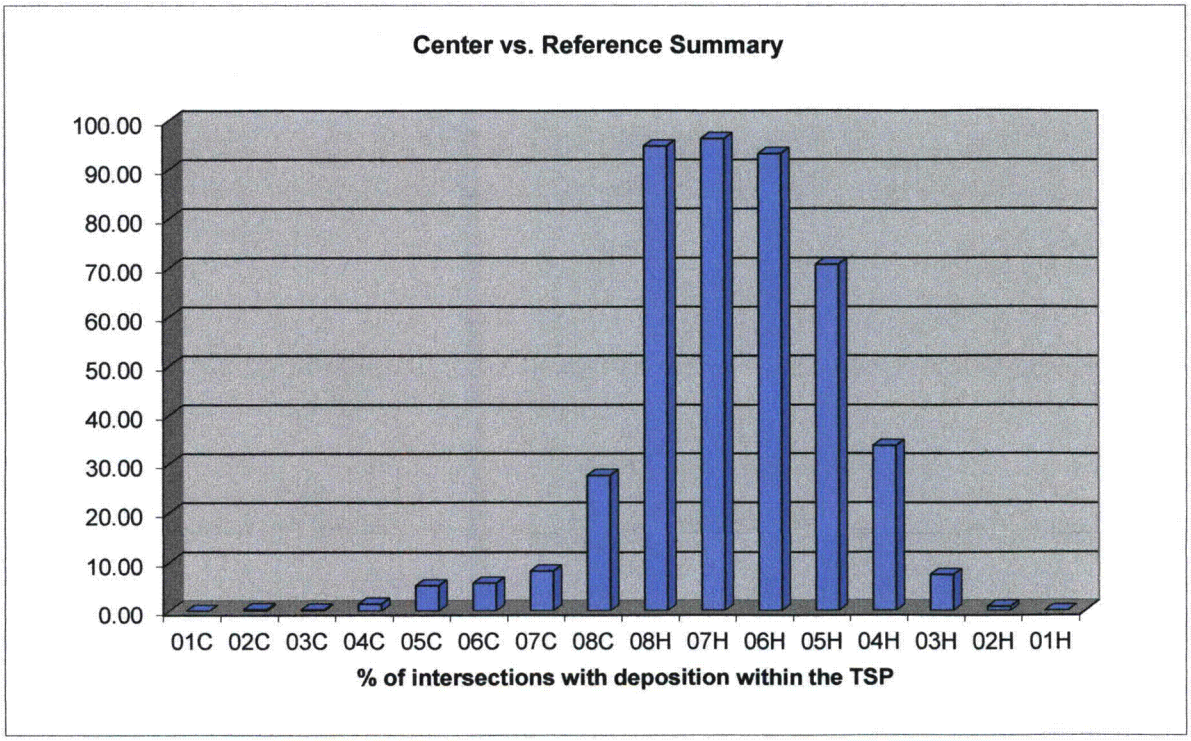
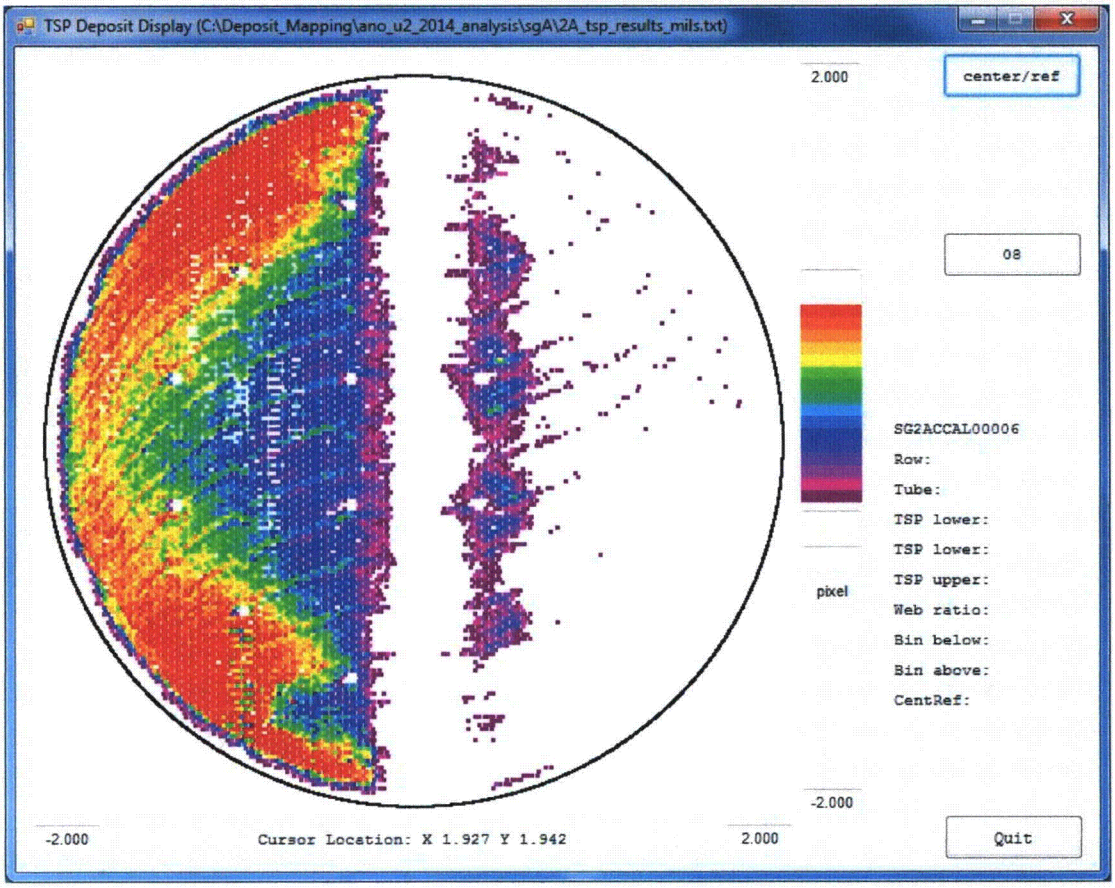


Figure 4

SGA 2R23 Top Support Plate Deposition Profile – "CentRef"



Notes:

1. The hot leg side of the SG is on the left
2. The color scale shows a qualitative representation of the amount of deposit as follows:
   a. The RED areas contain the tubes with the greatest amount of deposition
   b. The PURPLE areas contain the tubes with the least amount of deposition
   c. Tubes that had no deposition have no color associated with them and are left WHITE in the figure