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Subject: Arkansas Nuclear One - Unit 2
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License No. NPF-6
2P99 Steam Generator Tube Inspection

Gentlemen:

On November 5, 1999, Entergy Operations is scheduled to begin a mid-cycle outage (2P99) for the purpose of inspecting steam generator tubes for degradation in specific areas. The reasons for performing this inspection were previously discussed with the NRC staff in a presentation given on June 28, 1999. This letter supports the proposed Arkansas Nuclear One, Unit 2 (ANO-2) technical specification amendment for the 2P99 special steam generator inspection submitted on July 29, 1999 (2CAN079903). The planned scope and expansion criteria for the special steam generator tube inspection are described in the attachment to this letter.

During this inspection, Entergy Operations will repair all tubes identified as defective. If you have any questions regarding this submittal, please contact me.

Very truly yours,

for Jimmy D. Vandergrift
Director, Nuclear Safety

A001

JDV/jjd
attachment

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2P99 STEAM GENERATOR TUBE INSPECTION

This attachment outlines the scope and the expansion criteria for the Arkansas Nuclear One, Unit Two (ANO-2) 2P99 mid-cycle outage steam generator (SG) tube inspection. The inspection will consist of two parts, a bobbin campaign of the straight sections of the hot leg tubing in both generators and a minimal top of the tubesheet (TTS) inspection for circumferential cracking in the "A" steam generator. Both the scope and expansion criteria for these special inspections are discussed below:

Bobbin Scope

The bobbin scope of the 2P99 steam generator tube inspection includes the following:

- Tubes in both the "A" and "B" SGs will be inspected.

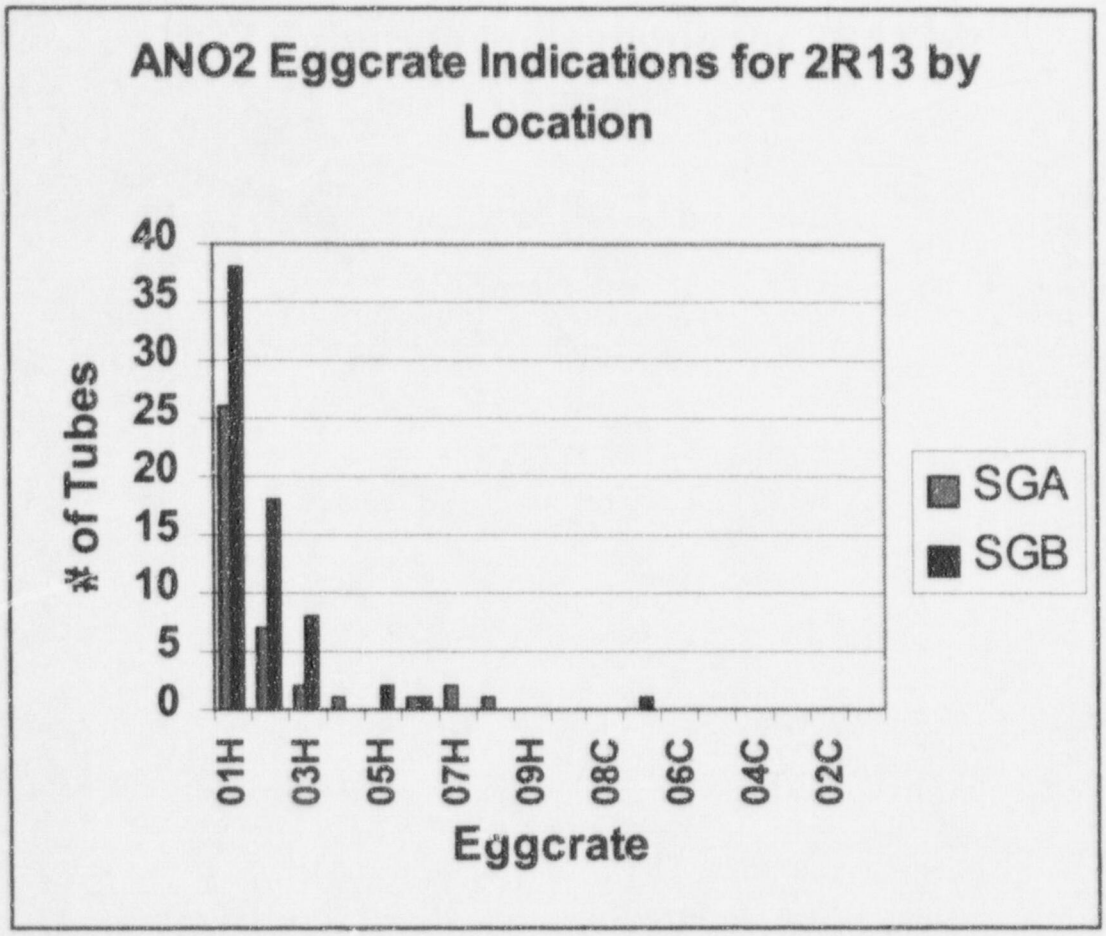
- In general, all inservice tubes will be inspected using a bobbin coil from the hot leg tube end to one inch above the seventh tube support plate (TSP) on the hot leg. For tubes that have been previously sleeved, the inspection will not include the sleeves and the remaining tube length between the sleeve and the tube end on the hot leg. The remaining portion of the sleeved tubes will be inspected from the cold leg.

- Bobbin indications confirmed by rotating pancake coil (RPC) will be repaired.

An operational assessment for the ANO-2 SG tubing was performed to evaluate the operating interval until the next outage. The assessment was submitted to the Staff on June 2, 1999 (2CAN069901). A mid-cycle inspection was planned due to the assessment results for axial cracks at the TSPs.

A review was performed to identify the locations of the indications detected in the previous inspection (2R13). As shown in Figure 1, the majority of the indications at the TSPs have been found in the lower sections of the hot leg side of the SG. This is due to the higher temperature effect on the flaw initiation and growth rate. The 2R13 inspection results are consistent with those of previous inspections. Because the lower hot leg tube sections have had the majority of axial indications, as well as the largest indications, these areas are of primary interest for the mid-cycle inspection. The inspection scope was conservatively modified to include inspection of the tubes to just above the seventh TSP.

Figure 1



Bobbin Expansion

The following expansion criteria will be used for indications identified by the bobbin probe:

- Because 100% of the inservice tubes will be included in the first inspection, no expansion is possible in the areas of interest (hot leg tubes from the TTS through the seventh TSP).

- If one confirmed indication is found in a tube within the tubesheet, the inspection will be expanded to include the area below the installed sleeves in the affected SG. The expansion would equal 666 tubes in the "A" SG and/or 197 tubes in the "B" SG. Since a large initial inspection will be performed in each SG, no expansion will be made into the unaffected SG.

TTS Scope

The TTS scope of the 2P99 steam generator (SG) tube inspection includes the following:

- Tubes in the "A" SG will be inspected.
- Tubes will be inspected +/- 2 inches of the TTS with a RPC probe.
- At minimum, 500 tubes in two areas of the SG where the largest circumferential indications have been previously identified will be inspected. The inspection area is identified on the attached tubesheet map.
- Tubes with circumferential indications not bound by previous in-situ pressure tests (based on percent degraded area and length) will be tested to 3 ΔP.

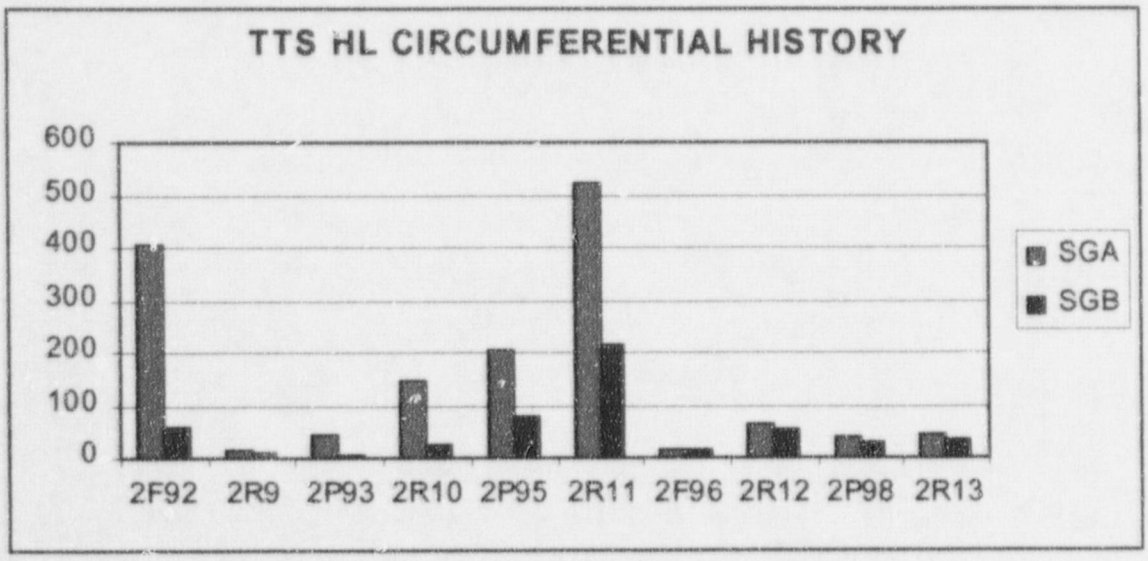
An operational assessment for the ANO-2 SG tubing was performed to evaluate the operating interval until the next outage. The assessment was submitted to the Staff on June 2, 1999 (2CAN069901). The evaluation concluded that from a circumferential cracking perspective, it was acceptable to operate for the full cycle. At the end of the operating cycle under postulated main steam line break conditions, the probability of burst is estimated at 0.0088 and leakage at 0.0460 gallons per minute. However for conservatism, Entergy Operations indicated during a June 28, 1999, meeting with the Staff that a limited scope TTS inspection would be performed during the planned 2P99 mid-cycle outage to minimize the potential for primary-to-secondary leakage through the SG tubing.

During the last SG inspection (2R13), 43 circumferential indications were identified in the "A" steam generator. The two largest indications were in-situ pressure tested to above 3ΔP. Both tubes passed without leakage or burst. The "A" steam generator has been the dominant generator for circumferential cracking by both size and number. Because of this, the examination will be limited to the "A" steam generator. Since the "A" steam generator has contained the largest flaws each outage, the "B" generator will not be tested. The only flaw in the "B" steam generator which could be considered large was found in the first TTS inspection in 1992. That flaw was actually located in a tube that was under expanded and the expansion transition was located ~ 4" below the top of the tubesheet. The crack however existed at the top of the tubesheet region in a dent. No large cracks have been found at the expansion transition in the "B" steam generator. All under-expanded tubes in both generators have been plugged. During the early years of operation the majority of the sludge and copper was transported to the "A" steam generator due to the design of the secondary plant demineralizer system. The demineralizer returned to the "B" hotwell which preferentially flowed to the "B" steam generator. The demineralizer both filtered and reduced the pH in the "B" train resulting in more solids and a higher pH environment in the "A" train. The elevated pH resulted in the original copper components (feedwater bundles) corroding and higher levels of

copper being transported to the "A" generator. The circumferential cracking is associated with the sludge pile that was deposited in the early years of operation. The size (percent degraded area or PDA) and number of indications in the "B" generator are, on general, dwarfed by those found in the "A" generator.

The ten TTS inspections performed over a seven-year period have yielded an extensive database. Circumferential cracking generally has shown a decreasing trend and has stabilized to a minimal value as noted in Figure 2 below. The cracking, as mentioned earlier, is associated with the kidney shaped sludge pile (see attached tubesheet map). The circumferential indications found to date have been primarily located at the edge of the sludge pile region concentrated around the stay cylinder. The sludge pile is actually two separate piles that form the lobes of the kidney. A large number of indications have been found at the edges of the two lobes. However, the indications at the edges of the lobes have been smaller than the flaws identified in the two areas on the right and left side of the stay cylinder (sample plan). Based on using PDA and evaluating the flaw morphology, the area between the lobes, as well as the center of the lobes (deep sludge pile), have a lower probability of developing a large flaw than the sample plan areas. The sludge pile has been monitored based on eddy current techniques and visually by sludge lancing equipment. Historically, the indications have developed at the edge of the kidney and moved only slightly toward the divider plate and stay cylinder. Since 1994, there have been no circumferential indications identified and in-situ tested that have leaked or burst The last ANO-2 inspection included 100% of the inservice tubes. The operational assessment performed following this inspection determined that full cycle operation would not result in an unacceptable risk to the public health and safety as a result of circumferential flaws.

Figure 2



Entergy Operations, in conjunction with the Electric Power Research Institute (EPRI), developed an evaluation of the cracking at the TTS expansion transition area. This program identified the structural adequacy of the tubing by PDA. The structural limit of ANO-2 tubing was determined to be 78 PDA. This criterion was developed to standardize the way circumferential cracks were sized to evaluate structural adequacy.

While developing the inspection plan, all previously in-situ pressure tested circumferential flaws were reviewed. This review consisted of evaluating the flaws based on 360 degree PDA as well as the morphology of the flaws. The morphology of the flaw evaluates the impact of ligaments between the non-planar cracks. Additionally, the largest of the most recently identified flaws (2R13) were included based on size. Typically, the largest indications based on PDA, length, and amplitude are tested based upon the EPRI in-situ pressure test guidelines.

Within the sludge pile region, two areas in the "A" SG have produced the largest circumferential cracks. An inspection plan was developed that includes these areas. Each area was chosen based on a bounding inspection of the region containing the large flaws. Taking the largest cracks (structural challenges and those that leaked at main steam line break conditions) from the 1992 and 1994 inspections and bounding them by 4 tubes would result in all the flaws $\geq$ 50 PDA since the 1992 inspection being contained. Additionally, the largest flaws identified in the most recent inspection (2R13), which were between 40 and 50 PDA, would also be bounded by this area. For the 2P99 inspection, the boxes were expanded to provide a buffer zone of at least two tubes around the previous large flaws. The area toward the divider plate and stay cylinder have been expanded also to accommodate the potential movement of the indications.

Approximately 500 inservice tubes were identified in the areas of interest so that as a minimum, a two-tube buffer zone would surround the identified in-situ tubes. Out of service tubes and previously sleeved tubes were not considered as part of the plan. It should be noted that a large portion of the tubes in this area have been previously repaired by plugging or sleeving.

The attached tubesheet map of the inspection plan shows the planned inspection locations. The blue areas show the tubes to be inspected. Red areas show the location of tubes which have been previously in-situ tested due to the largest identified circumferential flaws. Green areas represent tubes either sleeved or no longer in service.

Expansion Criteria

The following expansion criteria will be used for circumferential indications identified by the RPC probe:

- Failure of the circumferential indications in the "A" SG that meet the testing criteria to pass in-situ testing requirements of less than 1 gpm total leakage at main steam line break (MSLB) pressure (~2788 psig at room temperature*) or

burst of any single flaw at less than 3ΔP (~4515 psig at room temperature*) will cause an expansion. The expansion will be to inspect the TTS region of all inservice non-sleeved tubes in the "A" SG and a random 20% of the inservice non-sleeved tubes in the "B" SG.

- Failure of the circumferential indications in the "B" SG that meet the testing criteria to pass in-situ testing requirements of less than 1 gpm total leakage at MSLB pressure or burst of any single flaw at less than 3ΔP will cause an expansion to inspect the TTS region of all inservice non-sleeved tubes in the "B" SG.

* Pressure is adjusted for room temperature by 11.5%.

Expansion will be based on identification of a flaw that does not meet structural integrity or leakage requirements. Once the circumferential indications from the initial inspection have been identified and subsequently sized, they will be evaluated for in-situ pressure testing in accordance with the appropriate EPRI guideline. If an indication meets the in-situ pressure testing selection criteria, but is found to be bound by a previous ANO-2 SG in-situ pressure test, the indication will not be tested. If the indication is not bound, it will be tested. If the tested indication passes the acceptance criteria for burst and leakage defined above, no expansion is required. If the tube does not meet the requirements, further eddy current testing will be performed.

Arkansas Nuclear One - Unit 2

	GROUP	TUBES
s	sgattssp	503
	sgacircinsitulimited	11
	sgasleeves	900
	sgaplugs	1427

FTI - FDMS map module rev 1.1

S/G A
INLET
PRIMARY FACE

TOTAL TUBES: 8411
SELECTED TUBES: 2592
OUT OF SERVICE (#): NA

SCALE: 0.066191 X
Fri Aug 06 12:21:42 1999