



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 9, 2013

Vice President, Operations
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1 - REVIEW OF THE 2011 STEAM
GENERATOR TUBE INSPECTION REPORT (TAC NO. ME8279)

Dear Sir or Madam:

By letters dated March 22, 2012, and April 30, 2013, and e-mail dated October 25, 2011, Entergy Operations, Inc. (the licensee), submitted information summarizing the results of the fall 2011 steam generator (SG) tube inspections performed at Arkansas Nuclear One, Unit 1. The licensee discussed the progress and initial findings of the outage with the U.S. Nuclear Regulatory Commission (NRC) staff in conference calls that are summarized in letter October 12, 2012. The licensee participated in a Category 1 public meeting on January 26, 2012, to discuss tube-to-tube wear indications observed during the outage. The NRC staff also participated in a conference call with the licensee on June 12, 2013, to clarify a response in the licensee's letter dated April 30, 2013. Clarifications made by the licensee are included in the Enclosure.

The NRC staff has completed its review of this information and concludes that the licensee provided the information required by its technical specifications and that no additional follow-up is required at this time. The staff's review of the report is enclosed.

If you have any questions, please contact me at (301) 415-1480 or by e-mail at kaly.kalyanam@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "N. Kalyanam".

N. Kalyanam, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure:
As stated

cc w/encl: Distribution via Listserv

REVIEW OF THE 2011 STEAM GENERATOR TUBE

INSERVICE INSPECTION REPORT

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 1

DOCKET NO. 50-313

By letters dated March 22, 2012, and April 30, 2013, and e-mail dated October 25, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML12086A294, ML13121A428, and ML112990340, respectively), Entergy Operations, Inc. (the licensee), submitted information summarizing the results of the fall 2011 steam generator (SG) tube inspections performed at Arkansas Nuclear One, Unit 1 (ANO-1). The licensee discussed its progress and initial findings of the outage with the U.S. Nuclear Regulatory Commission (NRC) staff in conference calls that are summarized in letter October 12, 2012 (ADAMS Accession No. ML12276A301). The licensee participated in a category 1 public meeting on January 26, 2012, to discuss tube-to-tube wear indications observed during the outage; the meeting summary is available at ADAMS Accession No. ML120270416.

The NRC staff also participated in a conference call with the licensee on June 12, 2013, to clarify a response in its letter dated April 30, 2013. Clarifications made by the licensee are detailed below.

The SGs at ANO-1 were replaced in 2005 with enhanced once-through steam generators manufactured by AREVA. The vertical SGs are straight shell-and-tube heat exchangers, each containing 15,597 thermally treated Alloy 690 tubes. Each tube has a nominal outside diameter of 0.625 inches and a nominal wall thickness of 0.037 inches. The tubes were hydraulically expanded for the full depth of the tubesheet and are supported by 15 tube support plates (TSP). The TSPs are constructed of Type 410 Stainless Steel and contain broached trefoil shaped holes.

The licensee provided the scope, extent, methods, and results of its SG tube inspections in the letters referenced above. In addition, the licensee described corrective actions (i.e., tube plugging) taken in response to the inspection findings.

In the conference call on June 12, 2013, the licensee clarified the following points in its letter dated April 30, 2013 (which included the results from the Refueling Outage 24 (1R24) inspections in 2013):

- During the 2013 inspections, there was only one tube (row 25, column 72, R25C72) identified with three indications of tube-to-tube wear (TTW). The indications were generally at the same axial elevation (between 17.7-17.9 inches above the eighth tube support plate). The corresponding indications in the neighboring tubes were at the same approximate axial elevation. The three indications in the tube located at R25C72, were separated circumferentially by

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approximately 80 degrees. The largest indication in this tube was approximately 25 percent through-wall. The indications in the tube appeared to have only changed by 1-2 percent through-wall over one fuel cycle.

- The tubes surrounding the tube in R25C72 were inspected with bobbin and array probes. Two of the indications on the tube located on R25C72 appear to be caused by the tube at R25C71, and the third indication appears to be caused by the tube at R26C72. The tube at R26C72 appears to have created a 7 percent through-wall wear flaw in the tube at R26C73 during the cycle prior to the 2013 outage. In SG A, there are six tubes with two TTW indications. These wear indications are approximately 80 degrees apart. In SG B, there are eight tubes with multiple TTW indications (seven tubes have two TTW indications and one (R25C72) has three TTW indications).
- The licensee assessed the effects of tube bowing through laboratory testing and finite element analysis. This work was done to support assessments associated with tie-rod bowing. The maximum amount of lateral bowing was determined to be 2.3 inches. At this much bowing, denting of some of the tubes could occur (but it would not adversely impact the structural integrity of the tube). With this amount of bowing and considering 140 heatup and cooldown cycles, the finite element analysis indicated that the fatigue cumulative usage factor would still be below 1.
- The licensee plans to continue monitoring these tubes in future inspections. An operational assessment was performed by the licensee after 1R24 that supports two cycles of operation prior to the next inspection, when the licensee plans to perform an inspection of 100 percent of the SG tubes.

Based on the review of the information provided, the NRC staff has the following comments and observations:

- Tie-rod bowing was observed in SG B for the first time in the 2011 outage and is less severe than the tie rod bowing seen in SG A, which has been ongoing since the first inspection outage after SG replacement. The licensee postulates that there was a change in the surface conditions in SG B that increased the effective friction coefficient resulting in fully binding the TSPs during the previous operating cycle.
- During the 2011 outage, TTW was discovered in approximately 50 tubes in SG A and approximately 70 tubes in SG B. Most of the indications could be traced to the first inservice inspection; however, the results indicate that indications may develop after the first cycle and the depth of degradation may change with time (although the changes tend to be small). The maximum depth of the wear after four cycles of operation is 26 percent through-wall and has been constant for the last three cycles. The TTW appears to be self-arresting.
- The number of TSP wear indications in SG A has increased approximately 51 percent in SG A and 37 percent in SG B. The licensee indicated the wear

patterns in each of the SGs were essentially unchanged, but there appeared to be a new pattern of appreciable wear at TSP 6 in SG A. The maximum depth of TSP wear in 2011 was 46 percent through-wall, while the maximum depth in 2008 was only 32 percent through-wall. The licensee indicated the TSP wear at TSP 6 appears to be a function of the tube preload, which is under investigation as part of the TTW root cause assessment.

- One tube could not be stabilized as a result of bowing. The tube was plugged and the surrounding tubes were stabilized and plugged.

Based on a review of the information provided, the NRC staff concludes that the licensee provided the information required by its technical specifications. In addition, the staff concludes that there are no technical issues that warrant follow-up action at this time since the inspections appear to be consistent with the objective of detecting potential tube degradation. The staff will continue to monitor the licensee's assessment of the tie-rod bowing and tube-to-tube wear issues.

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/ra/

N. Kalyanam, Project Manager
Plant Licensing Branch IV
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