

May 13, 2005

Mr. Jeffrey S. Forbes
Site Vice President
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1 - ONCE-THROUGH STEAM
GENERATOR INSERVICE INSPECTION REPORT FOR REFUELING OUTAGE
1R17 (TAC NO. MB7282)

Dear Mr. Forbes:

By letter dated January 17, 2003, Entergy Operations, Inc. (Entergy) submitted its once-through steam generator (OTSG) tube inspection report for the Arkansas Nuclear One, Unit 1 (ANO-1) seventeenth refueling outage (1R17). This report is the 90-day report required by Technical Specification 5.6.7.a. By letter dated March 1, 2004, Entergy provided additional information in response to Nuclear Regulatory Commission (NRC) staff questions.

The NRC staff has reviewed Entergy's inspection report and additional information for the purposes of monitoring Entergy's OTSG inspection program and the status of tube degradation in the ANO-1 OTSGs. Based on our review, the NRC staff has identified no issues warranting further NRC staff follow-up at this time, with the exception of an issue that is being handled separately, as noted below.

Our review did not address Entergy's determination of the acceptability of their best estimate primary-to-secondary leakage expected for a large-break loss-of-coolant accident (LBLOCA). This best-estimate determination was performed to satisfy a commitment that Entergy made in support of License Amendment 212, dated March 28, 2001, to use a re-roll repair process for the ANO-1 OTSGs. The Babcock & Wilcox (B&W) Owners Group (B&WOG) is addressing the LBLOCA of concern in a generic investigation applicable to ANO-1. A meeting was held between the NRC staff and the B&WOG on February 24, 2005 (see meeting summary in the Agencywide Documents and Access Management System under Accession No. ML050880313) and a follow-up telephone conference call was held on April 26, 2005. The B&WOG plans to submit a topical report that addresses this issue before the end of 2005. The NRC believes that the generic B&WOG program is the proper place to address this LBLOCA issue since the technical nature of this issue is complex and generic to B&W plants.

J. Forbes

- 2 -

A copy of the NRC staff's review is enclosed.

Sincerely,

/RA/

Thomas W. Alexion, Project Manager, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure: As stated

cc w/encl: See next page

J. Forbes

- 2 -

A copy of the NRC staff's review is enclosed.

Sincerely,

/RA/

Thomas W. Alexion, Project Manager, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure: As stated

cc w/encl: See next page

DISTRIBUTION:

PUBLIC	RidsAcrsAcnwMail Center	SDinsmore
PDIV-1 Reading	RidsNrrDlpmLpdiv1 (AHowe) MRubin	
RidsOgcRp	RidsNrrPMTAlexion	WLyon
EMurphy	RidsNrrLADBaxley	JNakoski
LLund	RDennig	RidsRgn4MailCenter (AHowell)

Accession No.:ML051390532

*review input date

OFFICE	PDIV-1/PM	PDIV-1/LA	SRXB/(A)SC	SPSB/(A)SC
NAME	TAlexion	DBaxley	YHsii	ADrozd
DATE	5/12/05	5/12/05	5/11//05	5/12/05

OFFICE	EMCB/SC	PDIV-1/SC
NAME	LLund	WReckley for AHowe
DATE	04/05/04*	5/13/05

OFFICIAL RECORD COPY

REVIEW OF ONCE THROUGH STEAM GENERATOR (OTSG)
INSERVICE INSPECTION REPORT FOR
ARKANSAS NUCLEAR ONE, UNIT 1 (ANO-1)

Introduction

By letter dated January 17, 2003 (Agencywide Documents and Access Management System (ADAMS) Accession No. ML030220247), Entergy Operations, Inc. (Entergy or the licensee) submitted its OTSG tube inspection report for the ANO-1 seventeenth refueling outage (1R17). The content of the report was in accordance with Technical Specification (TS) 5.6.7.a. In addition, the licensee provided additional information by letter dated March 1, 2004 (ADAMS Accession No. ML040640914), concerning the inspections at ANO-1 in response to the NRC staff's requests for additional information (RAIs) on December 5, 2003, and January 29, 2004 (ADAMS Accession Nos. ML040770616 and ML040770235, respectively). The NRC staff reviewed the licensee's inspection report and RAI responses for the purposes of monitoring the licensee's OTSG inspection program and the status of tube degradation in the ANO-1 OTSGs.

Background

ANO-1 is a two-hot-leg/four-cold-leg plant with two OTSGs designed and manufactured by Babcock and Wilcox (B&W). Each OTSG has 15,531 tubes which are sensitized Alloy 600 mill annealed. Each tube is hard rolled expanded at each end against the upper and lower tube sheets, respectively, over a 1.5-inch length. The tubes are welded at each end to the tube sheet clad on the primary face of the upper and lower tube sheets.

The ANO-1 TSs are typical of those for plants with OTSGs, but have been amended in recent years to include:

- provision for sleeve repairs
- provision for re-roll repairs
- alternate tube repair criteria (ARC) applicable to axial tube-end cracks (TEC) that do not extend beyond the cladding interface into the carbon steel portion of the tube sheet
- ARC applicable to outer diameter (OD) intergranular attack (IGA) occurring within a defined region within the thickness of the tube sheet

Staff Review

In accordance with TS 5.6.7.a.1, the 90-day report included a description of the number and extent of tubes inspected. The scope of inspection performed during 1R17 included a 100 percent full length bobbin coil inspection of the tubes and 100 percent rotating pancake coil (RPC)/+Point inspection of the upper roll expansions, re-roll expansion repairs, and the

Alloy 600 sleeve expansions. In addition, RPC coils were used to characterize IGA indications and other indications found by bobbin.

TS 5.6.7.a.2 requires that the 90-day report include the location and percent through wall thickness penetration for each indication of an imperfection found by the inspection. The 90-day report includes the location of each indication found. However, with the exception of wear type flaws, the 90-day report does not include indication depth information. The licensee states that only wear flaws can be sized relative to the 40 percent plugging limit. Other types of indications are repaired on detection or dispositioned on the basis of an applicable ARC. With respect to wear flaws, the licensee did not report the actual depth measurement, but simply that the measured depth was less than the applicable 40 percent depth-based plugging limit. However, the licensee did state during a telephone call (documented in the NRC letter to Entergy dated December 6, 2002, ADAMS Accession No. ML023400530) that the maximum depth did not exceed 25 percent of the tube wall thickness. Based on this, the NRC staff did not request a more detailed breakdown of actual depth measurements for the wear indications.

As reported in the 90-day report, the ANO-1 OTSG tubes are degraded by a variety of mechanisms. These mechanisms and the inspection results for 1R17 are summarized below:

- TEC (both axial and circumferential) in the heat affected zone (HAZ) associated with the tube end welds
 - There were 2185 axial indications found. With the exception of five indications, all were acceptable for continued service per the applicable ARC. The tubes with the five exceptions were repaired. The 2185 indications found represents a relatively small increase compared to the 2044 indications found during the previous inspection (1R16), of which 1977 had been left in service.
 - There were 47 circumferential indications found. The affected tubes were repaired.
- cracks in the original upper hard roll expansions
 - There were 81 indications found, compared to 170 in 1R16. These were axial indications, with the exception of seven which were volumetric and one which was circumferential. All were repaired.
- cracks in tube re-roll repairs
 - There were 2551 indications found in the upper roll transition. These were mainly axial, but included 306 circumferential and five volumetric indications. These indications did not render the tubes pluggable or repairable since the upper transition is outside the pressure boundary as defined in Topical Report BAW-2303P, Revision 4, which is referenced by the TSs.
 - There were 38 indications, including 10 axial and 28 volumetric indications, within the pressure boundary region of the re-roll. These indications were repairable and compare with 70 such indications during 1R16.

- IGA occurring within the thickness of the upper tube sheet
 - There were 561 indications found, compared to 543 indications found during 1R16. These indications were assessed for acceptability for continued service in accordance with the methodology referenced in the TSs. This assessment revealed that the indications satisfied all statistical criteria to confirm that the indications had exhibited no growth since the previous inspection. This set of indications does not include axial, circumferential, and volumetric indications found at the re-roll repairs. This is consistent with the OD IGA ARC in the TSs, which applies only to indications up to the re-roll repair.
- tube wear at the tube support plates
 - There were 885 indications found, of which 261 were new indications. This compares with 741 indications found during 1R16. None of these indications were reported to exceed the applicable depth-based 40 percent throughwall plugging limit.
- axial flaws near the secondary face of the upper tube sheet
 - There were 8 axial indications reported. The affected tubes were plugged.
- free span axial and volumetric flaws
 - There were 54 axial and 4 volumetric indications reported. The affected tubes were plugged.

In accordance with TS 5.6.7.a.3, the licensee provided the identification of tubes plugged and sleeved during 1R17. Seventy-six and 43 tubes were plugged in OTSGs A and B, respectively. No tubes were repaired by sleeving. The cumulative equivalent plugging total (including the effects of sleeves) is now 1059 (6.82 percent of the tube population) and 467 (3.01 percent of the tube population) in OTSGs A and B, respectively.

In accordance with TS 5.6.7.a.4, the 90-day report included the number of tubes repaired by re-rolling and the number of indications detected in the new roll area of the repaired tubes. One hundred eighty-seven tubes in OTSG A and 154 tubes in OTSG B received re-roll repairs during 1R17. No indications were reported during the post process re-roll eddy current tests. However, as discussed earlier, indications were reported in re-rolls installed in earlier outages.

The licensee reports that its condition monitoring assessment indicates that the tube integrity performance criteria in Nuclear Energy Institute 97-06 were met at the end of Cycle 17 and that based on the comprehensive examinations performed, it concludes that the performance criteria will continue to be met through the end of the current operating cycle (Cycle 18). (Per Entergy letter dated August 3, 2004, Accession No. ML042240207, on a different subject, the OTSG tube inspections were completed on May 5, 2004, during the ANO-1 eighteenth refueling outage (1R18). Per Entergy letter dated May 10, 2004, Accession No. ML041340444, on a different subject, the OTSGs are scheduled to be replaced during the ANO-1 nineteenth refueling outage (1R19), scheduled for the fall of 2005.) The licensee stated that the structural implications of the observed degradation were either bounded by

previous in-situ pressure testing, or not considered to be a concern based on location of the degradation within the tube sheets.

The TSs do not require that the details of the condition monitoring and operational assessments be reported. However, in accordance with TS 5.6.7.a.5 and TS 5.6.7.a.6, the report contained a summary of the condition monitoring and operational assessment results with respect to the application of the TEC and upper tubesheet OD IGA ARCs. With respect to the ARC for axial TEC, the estimated main steam line break (MSLB) accident-induced leak rate is 0.55 gallons per minute (gpm) for OTSG A and 0.50 gpm for OTSG B based on the as-found indications during 1R17, factored up by 15 percent to account for undetected flaws. The NRC staff found this result to be reasonably consistent with expectations, based on the operational assessment performed following 1R16. The licensee's operational assessment for the axial TEC projected a MSLB leak rate of 0.38 and 0.27 gpm for the end of the current operating cycle (Cycle 18). The reason the projected leak rate is less than that associated with the as-found indications during 1R17 is that the licensee preventively plugged or repaired a number of tubes with axial TEC indications. Finally, the report notes that structural integrity is not a concern for this mechanism since it is located in the tube sheet and is, therefore, restricted from burst.

With respect to the OD IGA in the upper tube sheet, the estimated MSLB-induced leak rate is 0.11 gpm for OTSG A and 0.1 gpm for OTSG B, based on the as-found indications during 1R17, factored up by 10 percent to account for undetected flaws. The NRC staff found this result to be reasonably consistent with expectations, based on the operational assessment performed following 1R16. The licensee's operational assessment for the axial TEC projected an MSLB leak rate of 0.11 and 0.09 gpm for the end of the current operating cycle (Cycle 18). The reason the projected leak rate shows little change relative to that associated with the as-found indications during 1R17 is that this mechanism is not experiencing growth and that the licensee plugged or repaired 14 tubes with OD IGA indications for reasons other than the OD IGA. Finally, structural integrity is not a concern for this mechanism since it is located in the tube sheet and is, therefore, restricted from burst.

In its letter dated March 1, 2004, the licensee stated that the condition monitoring assessment of total MSLB-induced leakage from all degradation mechanisms for the most limiting OTSG (OTSG A) during 1R17 was 0.78 gpm. The licensee's 90-day report states that the projected total MSLB-induced leak at the end of the current Cycle 18 is 0.74 gpm for the most limiting OTSG (OTSG A), satisfying the applicable performance criteria of 1.0 gpm.

In accordance with a commitment made to the NRC by letter dated February 19, 2001 (Accession No. ML010590157), the licensee's 90-day report also documented the licensee's best estimate total leakage rate (1.87 gpm), which could be induced by a large-break loss-of-coolant accident (LBLOCA) based on circumferential cracks found at the original tube-to-tubesheet rolls, re-roll repairs, and HAZs of the seal welds. The licensee had previously reported this information to the NRC staff verbally during a telephone call (documented in the NRC letter to Entergy dated December 6, 2002). During that telephone call, the licensee stated that the allowable leakage limit for LBLOCA is 9 gpm.

In response to the NRC staff's RAIs dated December 5, 2003, and January 29, 2004, the licensee provided additional and clarifying information in its March 1, 2004, letter regarding its best estimate LBLOCA-induced leak rate and why it should be considered acceptable. The

licensee stated that the most significant parameter for tube leakage under LBLOCA conditions is the tube tensile loads created by differential thermal expansion (relative to the shell and tube sheets). The large axial loads pose a concern for tubes found to have circumferential cracks. Thus, the predominant contributor to LBLOCA is from circumferential cracks. The best estimate leakage values were a 2-minute value of 1.87 gpm and a 30-day value of 1.46 gpm, compared to the licensee's acceptance criteria of 9 gpm and 3 gpm, respectively. As stated in the cover letter, the NRC staff review did not address the licensee's determination of the acceptability of their best estimate primary-to-secondary leakage expected for a LBLOCA because the B&W Owners Group (B&WOG) is addressing the LBLOCA of concern.

The licensee's LBLOCA-induced leakage assessment considered all circumferential cracks found during the inspection. It should be noted that this included circumferential cracks found to exist above the re-roll repairs. For each circumferential crack, the leak rate was computed on the basis of the maximum resistance to primary-to-secondary leakage. This could be the crack geometry itself, the leak path around the roll or re-roll joints, or the annulus between the tube and tube sheet. The evaluation of the leak path around the joints considered the calculated tube sheet hole dilations as a function of tube sheet radial location. All circumferential cracks were evaluated structurally for potential severance as part of determining the limiting resistance to leakage for each indication. With one exception, all the circumferential indications found were located above a re-roll. The exception was a circumferential indication at the lower transition of the upper roll, which contributed 1.47 gpm of the total 1.87 gpm total leak rate.

Review Summary

In summary, the NRC staff has reviewed the licensee's 90-day report for OTSG tube inspections performed during 1R17 and the additional clarifying information, and has identified no issues on the OTSG inspection program or the status of tube degradation warranting further NRC staff follow-up action, with the exception of the best estimate primary-to-secondary leakage expected for a LBLOCA, which is being addressed separately with the B&WOG.

Principle Contributors: E. Murphy
W. Lyon

Date: May 13, 2005

Arkansas Nuclear One

cc:

Senior Vice President
& Chief Operating Officer
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Vice President, Operations Support
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Director, Division of Radiation
Control and Emergency Management
Arkansas Department of Health
4815 West Markham Street, Slot 30
Little Rock, AR 72205-3867

Wise, Carter, Child & Caraway
P. O. Box 651
Jackson, MS 39205

Winston & Strawn
1700 K Street, N.W.
Washington, DC 20006-3817

Mr. Mike Schoppman
Framatome ANP
3815 Old Forest Road
Lynchburg, VA 24501

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O. Box 310
London, AR 72847

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

County Judge of Pope County
Pope County Courthouse
Russellville, AR 72801

May 2005