March 9, 2006

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

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1 - SUMMARY OF CONFERENCE CALL WITH ENTERGY OPERATIONS, INC. TO DISCUSS REPLACEMENT STEAM GENERATORS (TAC No. MA7389)

On August 10, 2005, the Nuclear Regulatory Commission staff participated in a conference call with Arkansas Nuclear One, Unit 1, representatives regarding replacement steam generators. Enclosed is a summary of the conference call.

We appreciate your support in this matter. If you have any questions, please contact me at (301) 415-1436.

Sincerely,

/RA/

Drew Holland, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure:
Summary of Conference Call

cc w/encl: See Next Page

March 9, 2006

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

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1 - SUMMARY OF CONFERENCE CALL WITH ENTERGY OPERATIONS, INC. TO DISCUSS REPLACEMENT STEAM GENERATORS (TAC No. MA7389)

On August 10, 2005, the Nuclear Regulatory Commission staff participated in a conference call with Arkansas Nuclear One, Unit 1, representatives regarding replacement steam generators. Enclosed is a summary of the conference call.

We appreciate your support in this matter. If you have any questions, please contact me at (301) 415-1436.

Sincerely,

/RA/
Drew Holland, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure:
Summary of Conference Call

cc w/encl: See Next Page

DISTRIBUTION:

PUBLIC	RidsNrrPMDHolland	TBloomer
LPLIV-RF	RidsNrrDorlLplg	EMurphy
RidsNrrDorl	RidsAcrsAcnwMailCenter	KKarwoski
RidsOgcRp	RidsNrrLADJohnson	RJasinski
RidsRgn4MailCenter	RidsNrrPMMThadani	

ACCESSION No.: **ML060590367**
*No significant change from Branch input

OFFICE	LPLIV/LA	LPLIV/PM	CSGB/BC*	LPLIV/BC
NAME	DJohnson*	DHolland	AHiser	DTerao
DATE	2/28/06	3/09/06	11/08/05	03/09/06

OFFICIAL RECORD COPY

Arkansas Nuclear One

cc:

Senior Vice President
& Chief Operating Officer
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

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

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

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

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

SUMMARY OF CONFERENCE CALL REGARDING

REPLACEMENT STEAM GENERATORS

AUGUST 10, 2005

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 1

DOCKET NO. 50-313

On August 10, 2005, the Nuclear Regulatory Commission (NRC) staff participated in a conference call with Arkansas Nuclear One, Unit 1 (ANO-1) representatives regarding their replacement steam generators, which were re-scheduled to be installed in October 2005. The call focused on the design of the replacement steam generators and the actions taken by Entergy Operations, Inc. (the licensee) in response to inspection findings at Oconee Nuclear Station, Unit 1 (Oconee 1). Oconee-1 and ANO-1 both use once-through steam generators (OTSGs). A summary of the information discussed during the call, along with some background information, is provided below.

Oconee 1 has two OTSGs designed and fabricated by Babcock and Wilcox International (BWI). These OTSGs were put into service during refueling outage (RFO) 21 in 2003 (i.e., the original steam generators were replaced in 2003). Each OTSG has 15,631 thermally treated Alloy 690 tubes, which have an outside diameter of 0.625-inch and a nominal wall thickness of 0.038-inch. The tubes were manufactured by Sumitomo. The tubes are arranged in a triangular pattern with a spacing of approximately 0.875-inch. The heat transfer surface area is 134,600 square-feet. The total length of a tube is 674.1 inches with a heat transfer length of 629 inches.

At Oconee 1, the tubes were hydraulically expanded into the tubesheet for 13-inches from the tube-end. The tubesheets are 22-inches thick. The tubes are supported by 15 tube support plates constructed from 410 stainless steel. The tube support plate has trifoil shaped holes through which the tubes pass. The trifoils have an hour glass profile to improve hydraulic resistance (i.e., reduce the pressure drop across the plate), provide a flat contact surface for the tube, facilitate tubing of the OTSG, and provide better accessibility for water lancing and chemical cleaning. The trifoil land is 0.16-inch wide. The spacing between the tube supports was slightly modified in the replacement OTSGs with the bottom and top tube support plate being moved closer to the tubesheet. The open tube lane that was present in the original Oconee 1 OTSGs is tubed in the current OTSGs. Prior to placing the OTSGs into operation, one tube in each of the two OTSGs was plugged.

The first inservice inspection of the OTSG tubing following replacement of the original OTSGs started in April 2005. All of the inservice tubes were inspected full length with a bobbin coil. As a result of these inspections, approximately 11.5% of the tubes in OTSG A and 9.6% of the tubes in OTSG B had indications of wear at the tube support plate elevations. Most of the indications were located between the ninth (009) and eleventh (011) tube supports. In addition, most of the indications are shallow (less than 20% through-wall) and all of the tubes had adequate structural and leakage integrity. Some of the tubes had multiple indications at the same tube support elevation and some tubes had indications at multiple support plate elevations. Most of the indications are in the periphery of the tube bundle; however, there are

indications spread throughout the interior portion of the tube bundle. The largest indications are located approximately 5 tubes in from the periphery.

Due to the large number of tubes with degradation, a root cause investigation was commenced by Oconee 1 and BWI representatives to determine the extent of condition and the factors that led to the large number of tubes affected by wear. This root cause investigation continued through the end of 2005. Additional details concerning the findings at Oconee 1 are available in the NRC Agencywide Documents Access and Management System (ADAMS), under Accession Number ML051940482.

In October 2005, the original OTSGs at ANO-1 were replaced. The replacement OTSGs were fabricated by AREVA in France. The replacement steam generators arrived at ANO-1 on August 9, 2005.

Representatives from ANO-1 have been following the investigations at Oconee 1. At Oconee 1, several probable causes of the wear were identified (refer to ADAMS Accession No. ML051940482). These causes include: (1) tube vibration induced by motion of the OTSG, (2) excessive compressive loads in the tubes, (3) high wear rate coefficient for Alloy 690 against the 410 stainless steel tube support plates, (4) acoustically-induced tube vibration, (5) broached hole surface finish roughness, and (6) divergent nozzle created by the hourglass broached hole design. Each of these probable causes is discussed below.

Tube vibration due to the motion of the OTSG is not a significant concern for the ANO-1 replacement OTSGs, since the support skirt used in the original OTSG was retained in the design of the replacement OTSG. The Oconee 1 replacement OTSGs use a pedestal design which is less resistant to rocking motion. The ANO-1 representatives indicated that the Oconee 1 original OTSGs also had more wear than any of the other original OTSGs. The reason for this increased propensity for tube wear in the original OTSGs is not known.

The differential thermal expansion between the tubes and the steam generator shell can result in excessive compressive loads on the tubes. This is a result of the tubes tending to expand more than the shell, but being restricted from expanding by the tubesheet. Compressive tube loading can result in an increase in flow induced vibration and tube wear. As a result, the tubes are placed into tension at room temperature during fabrication. Alloy 690 expands more than Alloy 600 (i.e., the coefficient of thermal expansion for Alloy 690 is greater than that of Alloy 600). Due to temperature variations along the length of the tube, AREVA spent resources on optimizing the preload put into the tubes during fabrication to achieve the optimum preload during operation. In the replacement OTSG design at ANO-1, the goal was to put a slightly higher preload in the tubes than in the original OTSGs. In the Oconee 1 documentation (ML051940482), only one preload was identified in the replacement OTSG design rather than a range of preloads, so comparison with Oconee 1 is difficult.

With the right amount of tension at room temperature, the tubes will stay in tension or be slightly in compression during normal operation. In the ANO-1 replacement OTSGs, the tubes were placed into tension by hydraulically expanding the tubes into the lower tubesheet for the full length of the tubesheet with the upper tubesheet end free to move, followed by hard rolling and welding of the tube, then hydraulically expanding the tubes into the upper tubesheet for the full length of the tubesheet. This final hydraulic expansion produces the desired tensile preload. At Oconee 1, the tubes were hydraulically expanded into both the upper and lower tubesheet at

the same time. The tubes were only expanded for half the thickness of the tubesheet (i.e., expanded for 13-inches).

High wear rate coefficients between Alloy 690 and 410 stainless steel have been reported by the Electric Power Research Institute. The wear rate coefficients could be a factor of 2 or 3 higher than in the original steam generator design. In the replacement steam generators at ANO-1, the 410 stainless steel received a specialized heat treatment to reduce this wear coupling. Additional discussions are planned between ANO-1 and AREVA to discuss this issue.

With respect to the potential for acoustically-induced tube vibration, the ANO-1 representatives indicated that the steam aspirator port in the replacement OTSGs at Oconee 1 was changed to have a tapered edge. This is a potential area for vortex shedding. The steam aspirator port in the replacement OTSG at ANO-1 is not tapered, but it is 0.5-inch larger than in the original OTSGs. The spacing of the tube supports was also changed in the replacement OTSGs at Oconee 1 to provide more even spacing. This moved the nearest tube support farther away from the steam aspirator port. In the original OTSGs, there was approximately 13.5-inches from the bottom of the aspirator port to the nearest tube support. In the replacement OTSG design for Oconee 1, there is approximately 18-inches from the aspirator port to the nearest tube support. The irregular spacing of the tube supports in the original OTSGs was retained in the replacement OTSGs at ANO-1.

The surface finish roughness of the tube support plates is not a significant concern for the ANO-1 replacement steam generators. In the ANO-1 replacement OTSGs, the tube supports are 1.18-inches thick (compared to 1.5-inches in the original OTSGs and in the Oconee 1 replacement OTSGs), have broached trifoil-shaped holes (similar to Oconee 1), were fabricated from 410 stainless steel (similar to Oconee 1), and were fabricated to a finish of 30RA. The tube support lands at ANO-1 do not have an hourglass shape (unlike Oconee 1). There are still some drilled hole tube support locations at the upper tube support plates.

ANO-1 also reviewed the differential thermal expansion between the tube supports and the tubesheet. The tube supports (410 stainless steel) expand less than the tubesheet (carbon steel). This differential expansion could result in bowing the tube in the lower and upper spans of the tube (i.e., between the tubesheet and the nearest tube support). The extent to which this condition occurs depends, in part, on the amount of preload in the tube. If the tube comes into contact with one land, this could increase the wear rate. AREVA has indicated that this metal-to-metal contact could occur, but the effects are not considered significant.

The licensee for ANO-1 also discussed several other design changes between their original and replacement OTSGs. For example, the height of the upper shroud was increased to get it closer to the tubesheet (for better support). The range of clearances between the tube and the tube support plate were increased from 0.010- to 0.021-inch in the original design to 0.015- to 0.032-inch in the replacement OTSG design. AREVA expects the larger gap will increase the damping and result in less tube wear. This is based on test data. Discussions between AREVA and ANO-1 representatives are still on-going on this issue (Oconee 1 expects more wear for larger clearances).

The tube support plates in the ANO-1 replacement OTSGs are supported differently than that in the Oconee 1 replacement OTSGs. At ANO-1, the tube support plates are supported by stay rods. In the replacement OTSGs, the number of stay rods was increased compared to the

original design. The tube supports are free to slide in the replacement OTSGs at ANO-1. In the Oconee 1 replacement OTSGs, the edges of the tube supports are restricted from movement by blocks welded to the shroud. Because of differential thermal expansion, this could result in “cupping” of the tube support, which may lead to more wear in the periphery of the tube bundle. A combination of tube bowing or tube support plate “cupping” would be consistent with the observation of wear in the periphery and tapered wear scars near the edge of the tube support.

The ANO-1 replacement OTSGs have the same tube diameter, thickness, and pitch as the original OTSGs. The open tube lane was removed in the replacement OTSG design. The preservice inspection was done on site with the OTSGs in a horizontal position.

The ANO-1 representatives are following the root cause investigation into the Oconee 1 findings and are conducting their own assessments to ensure no safety significant issues exist with their replacement OTSGs.