June 29, 2005

LICENSEE: DUKE ENERGY CORPORATION

FACILITY: OCONEE NUCLEAR STATION, UNIT 1

SUBJECT: SUMMARY OF CONFERENCE CALLS WITH OCONEE, UNIT 1 REGARDING THEIR 2005 STEAM GENERATOR TUBE INSPECTIONS

On April 21, 22, and 26, 2005, the Nuclear Regulatory Commission (NRC) participated in conference calls with Duke Energy Corporation representatives regarding their 2005 steam generator tube inspection activities at Oconee, Unit 1.

The calls focused on the tube-to-tube support plate wear indications found during the inspection. The location of the indications as a function of the tube support plate elevation was provided by the licensee to support the calls. The licensee also provided background information regarding the tubes, the scope of the inspection, the inspection results and indicated that they would brief the NRC staff on the status of the root cause evaluation within a month. The NRC staff did not identify any issues with the licensee's steam generator tube inspections or repairs, however, the NRC staff will continue to monitor the licensee's root cause evaluation.

Attached is a summary of the conference calls and the supporting attachments used during the calls. If you have any questions, please contact me at 301-415-1419.

***/RA/***
Leonard N. Olshan, Senior Project Manager, Section1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 05-269

Attachment: As stated

cc: See next page

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| DATE | 06 / 28 /05 | 06 / 27 /05 | 06 / 29 /05 |

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## APRIL 21, 22, AND 26, 2005 CONFERENCE CALL SUMMARY

## STEAM GENERATOR TUBE INSPECTIONS

## OCONEE, UNIT 1

## DOCKET NO. 50-269

On April 21, 22, and 26, 2005, the Nuclear Regulatory Commission (NRC) staff participated in conference calls with Oconee, Unit 1 representatives regarding their 2005 steam generator tube inspections. The calls focused on the tube-to-tube support plate wear indications found during the inspection. A summary of the information discussed during the call along with some background information is provided below.

Oconee, Unit 1 has two once through steam generators designed and fabricated by Babcock and Wilcox International (BWI). These steam generators were put into service during RFO 21 in 2003 (i.e., the original steam generators were replaced in 2003). Each steam generator 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 $ft^2$. The total length of a tube is 674.1 inches with a heat transfer length of 629 inches.

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 steam generator, 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 steam generators 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, Unit 1 steam generators is tubed in the current steam generators. Prior to placing the steam generators into operation, one tube in each of the two steam generators was plugged.

The first inservice inspection of the steam generator tubing following replacement of the original steam generators 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 percent of the tubes in steam generator A and 9.6 percent of the tubes in steam generator B had indications of wear at the tube support plate elevations. The location of the indications as a function of tube support plate elevation was provided by the licensee and is attached. 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 percent 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.

Attachment

The repair criteria to be applied to these tubes were assessed during the outage. As part of this assessment, various analysis methodologies were investigated. A summary of the results of the various analysis methodologies was provided by the licensee and is attached. For example, the repair criteria were determined assuming the flaws would continue to grow at the 95th percentile rate (at 50 percent confidence) and that the flaws were undersized by 7.4 percent through-wall. The 7.4 percent through-wall underestimate was determined by comparing the non-destructive examination size estimate to actual sizes for several test specimens which indicated that 95 percent of the flaws would not be undersized by more than 7.4 percent through-wall at a 50 percent confidence level). The maximum size a flaw could be and still have adequate structural integrity was estimated to be 80.6 percent through-wall (based on a tapered wear scar of 1.0 inch). The repair criteria implemented during the outage were 28 percent through-wall. This resulted in plugging 30 tubes in steam generator A and 18 tubes in steam generator B. All plugged tubes were stabilized for the full length of the tube.

The root cause investigation involves determining the extent of condition and the factors that have led to the large number of tubes affected by wear. As part of the root cause evaluation to investigate the cause of these wear indications, a secondary side inspection was scheduled to be performed. The inspection will be performed in the area between the 10th and 11th tube support plates. This is an area where wear indications were detected. Attempts to visually see the wear patterns will be made and will concentrate on looking for deposits and anything unusual. However, since the wear indications are located behind the support plate, they may be difficult to see. The purpose of the inspection is to confirm that nothing unusual exists on the secondary side of the steam generator.

The startup of Oconee, Unit 1 was justified based on three activities. First, 100 percent of the tubes in both steam generators were inspected defining the extent of degradation in the steam generators. Second, a repair criteria were developed resulting in the plugging and stabilizing of 48 tubes. Lastly, BWI has developed a draft report which indicates that the structural integrity of the steam generator tubes is intact. This report highlights analysis activities and assumptions that form the basis for this conclusion. In the draft report, BWI concludes that the operability of all of the replacement once through steam generators at Oconee, Units 1, 2, and 3 is supported based on the following:

> The excitation mechanism is not fluidelastic instability and is not predicted to result in rapid tube failure in an unstable manner. Detailed analysis for fluid elastic instability was performed during the design of the steam generators. This conclusion is based on this analysis along with the nature of the wear marks observed at Oconee, Unit 1.
>
> The rate of wear is expected to follow a constant volume model. This is based on historic operating experience with BWI steam generators which indicate that wear growth (percent through-wall growth) is volumetric with respect to time and will at worst be linear. In developing the repair criteria at Oconee, Unit 1, linear growth was assumed.

Attachment

Wear scars at separate elevations along the length of individual tubes are independent events. That is, the wear rate at one support elevation is not affected by the wear rate at another tube support elevation along the length of the tube.

Degraded tube stresses due to the modal response of a tube containing an equivalent energy transfer rate as that experienced by the wear scar are less than the fatigue endurance limit of the tube material.

The vibratory tube bending stresses are less than the endurance limit based on the maximum deflection of a tube between two supports.

All of the steam generators at Oconee, Units 1, 2, and 3 are the same with respect to the design (i.e., same tube bundle and support arrangement) except that the tube support plates for Oconee, Units 2 and 3 were electropolished during fabrication. This electropolishing step may have increased the diameter of the trifoil shaped hole by up to 0.003 inch. Initial studies conclude that this increase in diameter may result in an increase in the wear rate at Oconee, Units 2 and 3 by 8 percent. If this is the case, analysis indicates that structural integrity would still be maintained.

The licensee's staff is reviewing and questioning each of assumptions and analysis techniques in the evaluation in order to independently validate the conclusions reached.

With respect to the causal mechanism, a re-review of the original models is being independently performed. In addition, thermal hydraulic experts are looking at what could be causing the wear. Theories and ideas are being developed and are being systematically evaluated. The causal mechanism may not be classic fretting wear. BWI is performing non-linear tube-to-tube support gap analysis based on the actual gap determined from eddy current testing (previous analysis assumed the gap was linear (same gap at all tube-to-tube support plate intersections)).

A detailed design review is being performed to compare the old design of the steam generators to the new design. In addition, plant operating parameters are being reviewed to identify any differences from what was considered in the design of the replacement steam generators.

The similarities between the three units are also being evaluated. For example, turbine vibration data, loose parts monitoring data, and other operational data from prior cycles are being reviewed. At this point in the evaluation, no significant differences between the units have been identified (nor has any significant difference between the last and prior cycles at Oconee, Unit 1 been identified).

Oconee, Unit 1 has Nitrogen-16 primary-to-secondary leakage monitors installed. The N-16 monitors at Oconee, Units 2 and 3 are in the process of being installed. The licensee has heightened its sensitivity to primary-to-secondary leakage.

At the end of the conference call, the licensee indicated that they would be willing to brief the NRC staff on the status of their root cause evaluation within a month, or so. The NRC staff did not identify any issues with the licensee's steam generator tube inspections or repairs. The NRC staff will continue to monitor the licensee's root cause evaluation.

Attachment: ONS1A EOC22 Examination Report

# ONS1A EOC22
# EXAMINATION REPORT

| | |
|---|---|
| Tubes Acquired | 15630 |
| Tubes Resolved | 15630 |
| Individual Tubes with WAR Indications | 1800 |

WAR Indications by Support

| | |
|---|---|
| **015** | 6 |
| **014** | 199 |
| **013** | 174 |
| **012** | 349 |
| **011** | 558 |
| **010** | 714 |
| **009** | 427 |
| **008** | 57 |
| **007** | 9 |
| **006** | 0 |
| **005** | 3 |
| **004** | 0 |
| **003** | 7 |
| **002** | 7 |
| **001** | 5 |

| | |
|---|---|
| Tubes 0 to 9% TW | 1155 |
| Tubes 10 to 19% TW | 791 |
| Tubes 20 to 29% TW | 68 |
| Tubes 30 to 39% TW | 17 |
| Tubes 40 to 49% TW | 3 |
| Tubes >49% TW | 0 |

4/22/20057:10 AM

ATTACHMENT A

Oconee Nuclear Station, Units 1, 2, and 3

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