February 28, 2005

Mr. R. T. Ridenoure
Division Manager - Nuclear Operations
Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
Post Office Box 550
Fort Calhoun, NE 68023-0550

SUBJECT: FORT CALHOUN STATION, UNIT NO. 1 - 2003 STEAM GENERATOR TUBE INSPECTION REPORT SUMMARY (TAC NO. MC4506)

Dear Mr. Ridenoure:

By letters dated October 27, 2003 (available in the Agencywide Documents Access and Management System under accession number ML033230486), and March 26, 2004 (ML040910288), Omaha Public Power District (OPPD) submitted the results of its 2003 steam generator tube inservice inspection pursuant to Section 3.17(5) of the Fort Calhoun Station, Unit 1 (FCS) technical specifications. By letter dated December 28, 2004 (ML043640019), OPPD responded to the staff's request for additional information. Additional information pertaining to the 2003 outage was summarized by the staff in a letter dated February 25, 2004 (ML040580502).

On the basis of its review of the above documents, the staff concludes that OPPD has provided the information required by the FCS technical specifications. This completes our review of the 2003 steam generator tube inspections at the FCS performed under TAC Number MC4506. A summary of the staff's review of the 2003 steam generator inspection results is enclosed.

If you have any questions or comments regarding this summary, please call me at (301) 415-1445.

Sincerely,

/RA/

Alan B. Wang, Project Manager, Section 2
Project Directorate
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosure: As stated

cc w/encl: See next page

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SUMMARY OF 2003 STEAM GENERATOR TUBE INSPECTION REPORT

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION, UNIT 1

DOCKET NO. 50-285

By letters dated October 27, 2003 (available in the Agencywide Documents Access and Management System under accession number ML033230486), and March 26, 2004 (ML040910288), Omaha Public Power District (OPPD) submitted the results of its 2003 steam generator tube inservice inspection pursuant to Section 3.17(5) of the Fort Calhoun Station, Unit 1 (FCS) technical specifications. By letter dated December 28, 2004 (ML043640019), OPPD responded to the staff's request for additional information. Additional information pertaining to the 2003 outage was summarized by the staff in a letter dated February 25, 2004 (ML040580502). A summary of the staff's review of the 2003 steam generator inspection results is below.

The FCS has two Combustion Engineering steam generators, RC-2A and RC-2B. The steam generator tubes are fabricated with mill-annealed Alloy 600. The tubes were explosively expanded for the full length of the tubesheet. Each steam generator has eight tube supports. The lower six supports (i.e., those nearest the tubesheet) support all of the tubes and are termed "full supports." The highest two supports are considered partial tube supports since they only support a limited number of tubes (i.e., only tubes in the periphery of the tube bundle are supported). The tube supports are numbered from 1 to 8, with 1 being the lowest tube support (i.e., nearest the tubesheet) and 8 being the highest.

Each of the eight tube supports has a patch plate region. The patch plate is the portion of the tube support structure that was attached to the remainder of the support following installation of the "main portion" of the support into the steam generator. The regions where the patch plates were eventually installed were used to provide access to the steam generator internals during and after installation of the main portion of the tube supports. Patch plates were located on both the hot and cold leg sides of the steam generators. The patch plate region has drilled holes for the passage of the tubes. The remainder of supports numbered 1 through 7 (i.e., the non-patch plate region) are of the eggcrate design. All of tube support number 8 is of the drilled hole design. The shapes of the patch plate region differ; however, tube supports numbers 1, 3, and 5 have the same shape, and tube supports numbers 2, 4, and 6 also have the same shape. Approximately 975 tubes pass through at least one drilled hole tube support, and several hundred tubes pass through drilled holes at each support plate elevation (i.e., the region where the patch plates are superpositioned).

At the location where the drilled hole portion of a support (i.e., the patch plate) meets the eggcrate, the tubes may pass through both supports (eggcrate and drilled hole). This region is referred to as the chord region. In this region the tubes are supported by both the drilled support plate and the eggcrate support plate at nearly the same axial location. The drilled support plate is positioned directly above the eggcrate support. The edge of the drilled plate is scalloped, having the shape of a series of semi-circles when viewed from above. Growth of the

drilled plate from denting could result in a bending strain at and below the eggcrate where the tube is restrained by movement in the lateral plane. This configuration is unique to the chord region.

The tubes are also supported in the U-bend region by diagonal bars, or batwings, and vertical strips. There are three vertical strips per steam generator. The vertical strips are connected to three structural I-beams, which are connected to the tube bundle shroud. Horizontal scalloped bars pass between each row of tubes and interlock with the vertical strips. Service induced denting occurred at the FCS during the initial few cycles of operation. As a result of this denting, a smaller (i.e., 0.560 inch) than normal bobbin probe is used for the tube inspection. This smaller diameter bobbin probe results in more probe wobble than would be present if a larger diameter probe is used. Dents (and dings) are reported when the bobbin voltage from the dent/ding is 3 volts or higher. The 3 volt reporting threshold was selected in 1998 as the level at which a 3 volt dent could be reliably differentiated from probe wobble.

Axial indications were identified in the freespan (67 indications), at drilled support plates (20), at eggcrate support structures (17), and within 2 inches of the top of the hot leg tubesheet (8). There were also two low level multiple axial indications identified above the seventh support in RC-2B. The majority of the axial indications were between the 5th and 8th support structure. This is the area where the partial tube support plates are superpositioned. This area is considered a critical area and 100 percent of this area was inspected with a rotating +Point™ coil. Most of the indications in the critical area were not detected with the bobbin coil and were only identified through the rotating coil inspections.

Circumferential indications were identified at the hot leg drilled support plates (18), at the top of the tubesheet on the hot leg side (2), at the 7th eggcrate support (1), and in the freespan (4). The four freespan indications are designated as such because they are not encompassed by a support structure. The circumferential indication at the 7th eggcrate support and two of the indications associated with the freespan are located in the chord region at the edge of the combination eggcrate/ drilled plate supports. These locations have been identified as a critical area and will undergo 100 percent examination by the +Point™ coil during the 2005 inspection. The other two freespan indications are considered by the licensee to be within the influence region of the drilled support plates. One indication was immediately above the top edge of the 7th drilled support plate and the other was immediately below the 8th drilled support plate. The drilled support plates are inspected 2 inches above and 2 inches below the center of the supports. The licensee did not provide the basis for this scope of examination above and below the tube support in its tube inspection reports. If additional circumferential indications are detected outside the critical areas during the next outage, additional information may be necessary to ascertain the basis for the criteria.

In RC-2B several indications at the 8th drilled support plate were characterized as being a series of parallel circumferential cracks. Ultrasonic investigation of tube R94/C65 revealed six circumferential indications stacked axially within the 8th support plate. As measured by +Point™ coil this indication had an axial extent of 0.71 inch and a circumferential extent of 137 degrees. There are 14 circumferential indications at support locations that appear to have layers of degradation. The 8th drilled support plate experienced significant volumetric expansion due to corrosion early in the life of the steam generators. This expansion caused tube denting and

deformation. The edge supports of the plates were cut out to relieve stresses in the plate. The licensee believes that the layers of circumferential cracking are caused by the continued volumetric expansion of the support plate. The expansion of the plate is believed to compress the tube radially and stretch the region of the tube in contact with the plate in the axial direction. The cracks are parallel and are separated axially. The licensee does not believe that the cracks can coalesce into a larger crack based on their orientation to one another. A leak test was performed on the indication with the greatest +Point™ voltage. No leakage resulted from the test.

A total of 115 tubes were plugged in steam generators RC-2A and RC-2B during the 2003 outage. Tubes with circumferential indications were stabilized. Eight tubes were removed from service to accommodate the future use of a flat rail system. Two tubes were plugged because of wear associated with loose parts.

No flaws were detected in the 100 percent high frequency +Point™ coil sample in the U-bend region of rows 1 and 2. A 20 percent sample of the U-bend region of the tubes in rows 1, 2, 3, and 4 was conducted with a mid-frequency +Point™ coil. No flaws were reported from the mid-frequency coil data. No primary water stress-corrosion cracking or outer-diameter stress-corrosion cracking has been reported to date in the low row U-bends at the FCS.

In order to validate the analysis methodology, 20 percent of the bobbin indications previously inspected with a rotating probe and which showed no change from previous bobbin coil data were retested with a rotating probe. No flaws were identified in the rotating probe sample.

Based on a review of the information provided, the staff concludes that the licensee provided the information required by their 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 and the inspection results appear to be consistent with industry operating experience at similarly designed and operated units.