

January 23, 2004

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

SUBJECT: FORT CALHOUN STATION, UNIT 1 – NRC ASSESSMENT OF 2002
REFUELING OUTAGE STEAM GENERATOR INSPECTION REPORT
(TAC NO. MB6954)

Dear Mr. Ridenoure:

By letters dated July 1, 2002, and December 3, 2002, Omaha Public Power District (OPPD) submitted the results of its 2002 steam generator tube inservice inspection pursuant to Section 3.17(5) of the Fort Calhoun Station, Unit 1 (FCS) Technical Specifications. After the staff's preliminary review of OPPD's steam generator tube inspection results, the staff issued a request for additional information dated May 9, 2003. By letter dated July 30, 2003, OPPD responded to the staff's request for additional information. In a related matter, by letter dated September 17, 2002, the NRC forwarded to OPPD a summary of the phone calls with the OPPD representatives held on May 9 and May 17, 2002, regarding the steam generator tube inspection activities at the FCS in 2002.

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. However, as discussed in the enclosed assessment, the staff has identified a number of additional questions pertaining to the scope and results of the licensee's 2002 inspections. Given that the licensee's 2003 steam generator tube inspections have begun for the September 2003 refueling outage, additional follow-up on these questions and comments will be documented as part of our review of the licensee's 2003 tube inspection results. This completes our review of the 2002 steam generator tube inspections at the FCS performed under TAC No. MB6954.

Sincerely,

/RA/

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

Docket No. 50-285

Enclosure: Assessment

cc w/encl: See next page

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NRC ASSESSMENT OF 2002 STEAM GENERATOR INSPECTION REPORT

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN UNIT 1

DOCKET NO. 50-285

By letters dated July 1, 2002 (Accession No. ML021910122), and December 3, 2002 (Accession No. ML023400505), Omaha Public Power District (OPPD) submitted the results of its 2002 steam generator tube inservice inspection pursuant to Section 3.17(5) of the Fort Calhoun Station, Unit 1(FCS) Technical Specifications (TS). After the staff's preliminary review of the OPPD's steam generator tube inspection results, the staff issued a request for additional information dated May 9, 2003 (Accession No. ML031290367). By letter dated July 30, 2003 (Accession No. ML032130184), OPPD responded to the staff's request for additional information. In a related matter, by letter dated September 17, 2002 (Accession No. ML022490219), the NRC forwarded to OPPD a summary of the phone calls with the OPPD representatives held on May 9 and May 17, 2002, regarding the steam generator tube inspection activities at the FCS in 2002.

FCS has two Combustion Engineering (CE) 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 one to eight, with one being the lowest tube support (i.e., nearest the tubesheet) and eight 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 side of the steam generator. The patch plate region has drilled holes for the passage of the tubes. The remainder of Supports Nos. 1 through 7 (i.e., the non-patch plate region) are of the eggcrate design. All of tube Support No. 8 is of the drilled hole design. The shapes of the patch plate region differ; however, tube Supports Nos. 1, 3, and 5 have the same shape, and tube Support Nos. 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).

The tubes are also supported in the U-bend region by diagonal bars, or batwings, and vertical straps. There are three vertical straps per steam generator.

Service induced denting occurred at 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 three volts or higher. The three volt threshold was selected since it was concluded that a three volt dent could be reliably differentiated from probe wobble at this threshold. Approximately 14,000 locations have dents greater than 3 volts at tube support structures (eggcrates, drilled holes, diagonal bars, vertical straps).

At the tube supports (eggcrate and drilled hole regions), the dominant cracking mechanism is outside diameter stress corrosion cracking (ODSCC). Both axial and circumferential ODSCC have been observed. Axial ODSCC has been detected at both dented and non-dented locations. In addition, circumferential ODSCC has been detected at both dented and non-dented tube supports. All of the circumferential ODSCC indications detected at FCS have been located at drilled hole locations. No circumferential ODSCC has been detected at eggcrate tube supports at FCS or in any other CE-designed steam generators. Only one primary water stress corrosion cracking (PWSCC) indication has been observed to date at tube supports. This indication was detected in 2002 during the random +Point™ examination of dented eggcrate tube supports. The indication was axial in nature and located in the eggcrate portion of the second hot leg tube support (i.e., 2H). The tube had a 31 volt dent at this location.

During the 2002 inspection, a rotating probe was used to inspect all hot-leg drilled hole supports (both dented and non-dented). A rotating probe was also used to inspect all dented eggcrate locations at H1 and H2, and a 20 percent rotating probe examination was conducted at other dented eggcrate locations. A random sample of non-dented eggcrate locations was not performed.

To date, no flaws have been detected in free span dings. During 2002, a rotating probe was used to inspect 20 percent of the freespan dings.

Axial ODSCC has been detected in the area where the drilled hole tube supports are superpositioned. Flow is restricted in this region since deposits accumulate in the flow holes of the drilled support regions. The cracking in this region not only occurs at the tube supports but also in the free span region. The critical area determined by the superposition of the drilled hole tube supports is bounded axially within the steam generator by tube support H5 and the hot-leg diagonal bar. The critical area was inspected with a +Point™ probe in 2002.

Axial and circumferential indications were detected at the hot-leg expansion transition region during the 2002 inspection. A rotating probe was used to inspect the expansion transition region of 100 percent of the tubes.

After reviewing the licensee's submittals including the submittal dated July 30, 2003, which was provided in response to an NRC request for additional information, the NRC staff identified additional questions pertaining to the scope and results of the licensee's 2002 inspections. Given that the licensee's 2003 steam generator tube inspections have begun for the September 2003 refueling outage, the staff elected to discuss these questions in the context of the licensee's planned 2003 inspections. The nature of the staff's questions and comments are as follows:

1. Please provide the scope of planned 2003 inspections for all dented regions (i.e., dents in freespan, dents at drilled hole tube supports, dents at eggcrate supports, dents at non-horizontal tube supports, and dents at cold-leg supports).
2. Please provide the justification for using a three volt reporting threshold for dents given the recent inspection findings (axial PWSCC detected at a dent and circumferential ODSCC detected in less than three volt dents) and the technique qualifications (e.g., is bobbin technique qualified to detect flaw in dents whose voltage is less than three volts?).
3. Clarify that the dent calibration at FCS is similar to dent calibration in the industry qualification data sets for PWSCC and ODSCC.
4. Scope of rotating probe inspections for non-dented regions (free span, eggcrates, non-horizontal tube supports) given that circumferential flaws have been detected in non-dented regions. Root cause of these indications.
5. Additional details regarding the one PWSCC indication detected at FCS.
6. Site-specific qualification of eddy current techniques given the inspection challenges (e.g., denting) at FCS.
7. Lessons learned from Comanche Peak (refer to Information Notice 2003-05, "Failure to Detect Freespan Cracks in PWR Steam Generator Tubes").
8. Increase in the voltage magnitude of dents (voltage growth).

Additional follow-up on these questions and comments will be documented as part of the NRC's review of the licensee's 2003 inspections.

This assessment completes the staff's review of the licensee's 2002 steam generator tube inspection report.

Ft. Calhoun Station, Unit 1

cc:

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