Omaha Public Power District

444 South 16th Street Mall
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December 28, 2004
LIC-04-0132

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, D.C. 20555

References:
1. Docket No. 50-285
2. Letter from OPPD (Ross T. Ridenoure) to NRC (Document Control Desk) dated October 27, 2003, Fort Calhoun Station Steam Generator Tube Plugging Report - 2003 Refueling Outage (LIC-03-0147)
3. Letter from OPPD (R. L. Phelps) to NRC (Document Control Desk) dated March 26, 2004, Fort Calhoun Station (FCS) Steam Generator Eddy Current Test Report - 2003 Refueling Outage (LIC-04-0040)
4. Letter from NRC (Alan B. Wang) to OPPD (R. T. Ridenoure) dated November 22, 2004, Request for Additional Information (TAC No. MC4506) (NRC-04-0139)

SUBJECT: Response to Request For Additional Information Concerning the 2003 Steam Generator Inservice Inspection Reports

In support of References 2 and 3, the Omaha Public Power District (OPPD) provides the attached response to the Nuclear Regulatory Commission's (NRC's) Request for Additional Information of Reference 4.

No commitments to the NRC are made in this letter.

If you have any questions or require additional information, please contact Thomas R. Byrne of the Fort Calhoun Station Unit No. 1 Licensing staff at (402) 533-7368.

Sincerely,

R. L. Phelps 12-28-04

R. L. Phelps
Division Manager
Nuclear Engineering

RLP/TRB/trb

Attachment 1: Response to Request For Additional Information Concerning the 2003 Steam Generator Inservice Inspection Reports

ATTACHMENT 1

Response to Request For Additional Information Concerning the 2003 Steam Generator Inservice Inspection Reports

Question 1:

During conference calls conducted between the staff and representatives from OPPD on August 29, 2003, and October 2, 2003, (see conference call summary dated February 5, 2004 [ADAMS Accession No. ML040580502]), OPPD indicated that ultrasonic inspections were planned to be performed on 7 tubes. These ultrasonic inspections were planned for a tube in Row 94 Line 61 where the circumferential flaw was coincident with the top edge of the tube support. The intent of the examinations was to confirm the degradation mechanism, profile the tube at the location of the defect, and size the flaw. Ultrasonic testing was performed on 12 indications in 7 tubes. Please discuss the results of these ultrasonic inspections including any lessons learned as a result of the inspections and how the results will be factored into future inspections.

OPPD Response:

The Westinghouse ultrasonic test-eddy current (UTEC) tool was used to obtain additional information on the nature of the eddy current indications. The UTEC has three transducers: a straight beam used for wall thickness measurements, profilometry measurements, and detection of volumetric flaws, and two shear wave oriented transducers for axial and circumferential flaw detection.

The primary objectives of UTEC ultrasonic testing were:

1) Confirm the presence of freespan circumferential cracking
2) Confirm the presence of multiple layers of circumferential cracking at tube support plate intersections
3) Determine whether denting or tube ovalization was present at supports where the ECT bobbin did not show a dent

A total of seven tubes was selected for examination, some with multiple areas comprising a total of nine test areas. Selected results from the ultrasonic examination are listed below.

Freespan Circumferential Indication

Row/Line	Eddy Current	UTEC
R84 L73	General	Group of 4 indications located at or below the H7 eggcrate. There is ovalization at the support plate elevation which measures as a .0044 in. bulge/.0057 in. dent. However, there is no measurable profile distortion at the location of the indications.
	SCI@H7+0.48	**Indication** 0: Patch of Scattered OD circ. Indications 81°x.59 in. extent corresponding with UTEC RPC indication. No evidence of OD wall loss seen by UTEC straight beam. No axial component to these indications. Max depth measurement 46% TW.
	SVI@H7-0.55	**Indication** 1: Intermittent OD circ. indication 59° extent corresponding with UTEC RPC indication. No evidence of OD wall loss seen by UTEC straight beam. No axial component to this indication. Max depth measurement 45% TW.
	SCI @H7-2.38	**Indication** 2: Single OD circ. indication 30° extent corresponding with UTEC RPC indication. No evidence of OD wall loss seen by UTEC straight beam. No axial component to this indication. Max depth measurement 38% TW.
	SVI @H7-2.66	**Indication** 3: Single OD circ. indication 26° extent corresponding with UTEC RPC indication. No evidence of OD wall loss seen by UTEC straight beam. No resolvable tip diffraction signals; depth estimate 20-30% TW. Some OD deposit influence in this area seen on straight beam and circumferential aim (UT2) transducer.

Multiple Layers of Circumferential Cracking

Row/Line	Eddy Current	UTEC
R94/L65 H8	SCI @H8	Group of 6 resolvable circumferential OD indications within the support plate. 140° x .64 in overall extent. The longest indication is 133° with a depth of 49%. The deepest indication measures 62% deep with a length of 113°. The intersection is ovalized, and the indications are found in the area of maximum bulging, measured as .0116 in. radially. No OD wall loss or axial indications. UT also shows

		no support plate contact in same area that ET indicates a missing segment.

Multiple Layers of Circumferential Cracking

Row/Line	Eddy Current	UTEC
R94/L63 H8	SCI @H8	Group of circumferential OD indications within the support plate. 129° x .43 in overall extent. Two dominant indications are resolvable from this group; indication "0" with 44% max depth and 92° length and indication "1" with 39% max depth and 93° length. The intersection is ovalized, and the indications are found in the area of maximum bulging, measured as .0138 in. radially. No OD wall loss or axial indications.
R94 L61	SCI @ H8	Group of circumferential OD indications within the support plate 111° x .32 in. overall extent. Two dominant indications are resolvable from this group; indication "0" with 57% max depth and 100°, and indication "1" with 57% max depth and 69° length. The intersection is ovalized, and the indications are found in the area of maximum bulging, measured as .0119 in. radially. No OD wall loss or axial indications.
R95 L66	SCI @ H8	Group of 6 resolvable circumferential OD indications within the support plate. 120° x .47 in. overall extent. The longest indication is 77° with a depth of 57%. The deepest indication measures 63% with a length of 57°. The intersection is ovalized, and the indications are found near the area of maximum bulging, measured as .0051 in. radially. No OD wall loss or axial indications. UT also shows no support plate contact in same area that ET indicates missing segment.

No Dent by Bobbin Coil ECT

Row/Line	Eddy Current	UTEC
R90/L77 H1	SCI @H1	Small (18°) OD circ indication within support. Max depth measurement 71% TW. UTEC profilometry shows a 0.0022 in. bulge in this area.

Circumferential Indication at Upper Edge of Support

Row/Line	Eddy Current	UTEC
R94/L61 H7	SCI @H7 *	Possible UTEC RPC indication centered .12 in. above support. No Resolvable UT indications at this location.

Low Confidence Plus Point Indications Not Confirmed by Delta Coil

Row/Line	Eddy Current	UTEC
R93 L66	SCI @ H8	NDD. There is a .0039 in. dent near the top of the support plate.
R93 L66	SAI @ H7	OD axial scratch or gouge extending length of scan. No measurable depth to this scratch, although amplitude is high for 1 inch length above support. Otherwise NDD

Assessment of Ultrasonic, Plus Point, and Delta Coil Results

Although there were minor discrepancies between the ECT and UT results, in general the ECT findings were corroborated by the UT. The freespan cracking in RC-2B R84/C73 was confirmed and the multiple layers of cracking in RC-2B R94/C65 was also confirmed. The presence of bulging was detected in a tube support intersection with circumferential cracking but no observed geometry response from the bobbin coil (RC-2B R90/C77). Depth estimates were provided from the UT test using tip diffraction time of flight measurements and the length and width of the flaw areas were estimated as well. In general there is good agreement between the ECT and UT sizing estimates although it should be noted that this is a very small data set for comparison and there is no Appendix J qualification which quantifies the UT sizing error.

Tube R94/C61 was added to the test list to investigate a circumferential response from the plus point coil at the upper edge of H7. This indication was confirmed by the delta coil and historical reviews of prior cycle data show that the indication was not present in 1999. The UT did not corroborate this flaw although there is some deposit noise in this area which could potentially mask a low level flaw. The delta ECT test established with high confidence that the origin of the signal is not volumetric which would be expected with a deposit. The lack of a response on the circumferentially oriented coil, which is insensitive to circumferential cracks, coupled with a positive response from the axially oriented coil is much more consistent with a crack than a volumetric indication.

* Bobbin coil shows presence of a dent at this location in the 2 to 3 volt range.

With respect to the question of lessons learned and how they will be incorporated into future inspections, the ultrasonic test results basically confirmed the analysis of the ECT probe data.

Recently two tubes were removed from another plant with I600TT tubing to investigate circumferential ODSCC reported in the tubesheet expansion transition. The flaws were reported by the ECT plus point coil and were confirmed by UTEC. The destructive examination showed no evidence of corrosion and it is believed that the false positive NDE results were actually deposits rather than flaws. In the case of Fort Calhoun Station (FCS), there are also deposits which could result in similar false positive flaw calls, however it is our judgment that the indications are probably valid flaw responses.

The ECT indications will be incorporated into the data analysis indoctrination, training data sets, and site specific performance demonstration for the 2005 inspection.

Question 2:

On page 4 of the March 26, 2004, letter, OPPD indicated that 100 percent of the hot leg drilled support intersections were tested for circumferential outside diameter stress corrosion cracking (ODSCC), axial ODSCC, mechanical wear, and axial primary water stress corrosion cracking (PWSCC). Similar statements were provided for inspections at other locations. Please confirm that the inspection data were also reviewed to identify other potential forms of degradation at these locations (e.g. circumferential PWSCC).

OPPD Response:

The data analysts screen the data for all known damage forms. To date, we have not detected circumferential PWSCC at FCS; however, the technique (plus point) that is used is sensitive to this mechanism as well.

Question 3

In the March 26, 2004, letter, OPPD stated that 114 axial indications were identified. However the locations of only 112 indications are reported (67 freespan, 20 at drilled supports, 17 at eggcrate supports, and 8 near the hot leg top of tubesheet). Please identify the locations of the two axial indications that were not described in the report.

OPPD Response

The two entries which were left out of the total had multiple axial indications (MAI) while the remainder were all single axial indications (SAI). These two tubes are identified in Table 3 of the

inspection report. Row 92 Line 73 had MAI calls at H7 + 13.92 and H7 + 14.99 inches. Both are low level flaws.

Question 4

During the conference calls discussed above, OPPD indicated that 20 percent of indications previously inspected with a rotating probe which show no change by bobbin coil will be retested with a rotating probe during the 2003 examination to further validate the analysis methodology. Please discuss the results of these examinations.

OPPD Response

No flaw indications were reported in the 20% samples performed in each steam generator.

Question 5

In steam generator B, a single circumferential indication (SCI) was located at the seventh eggcrate support and four SCls were located in the freespan (areas not encompassed by a support structure). Please discuss any unique circumstances, including dents, associated with these indications and discuss the implications for future susceptibility of the eggcrate supports and freespan region to circumferentially oriented degradation.

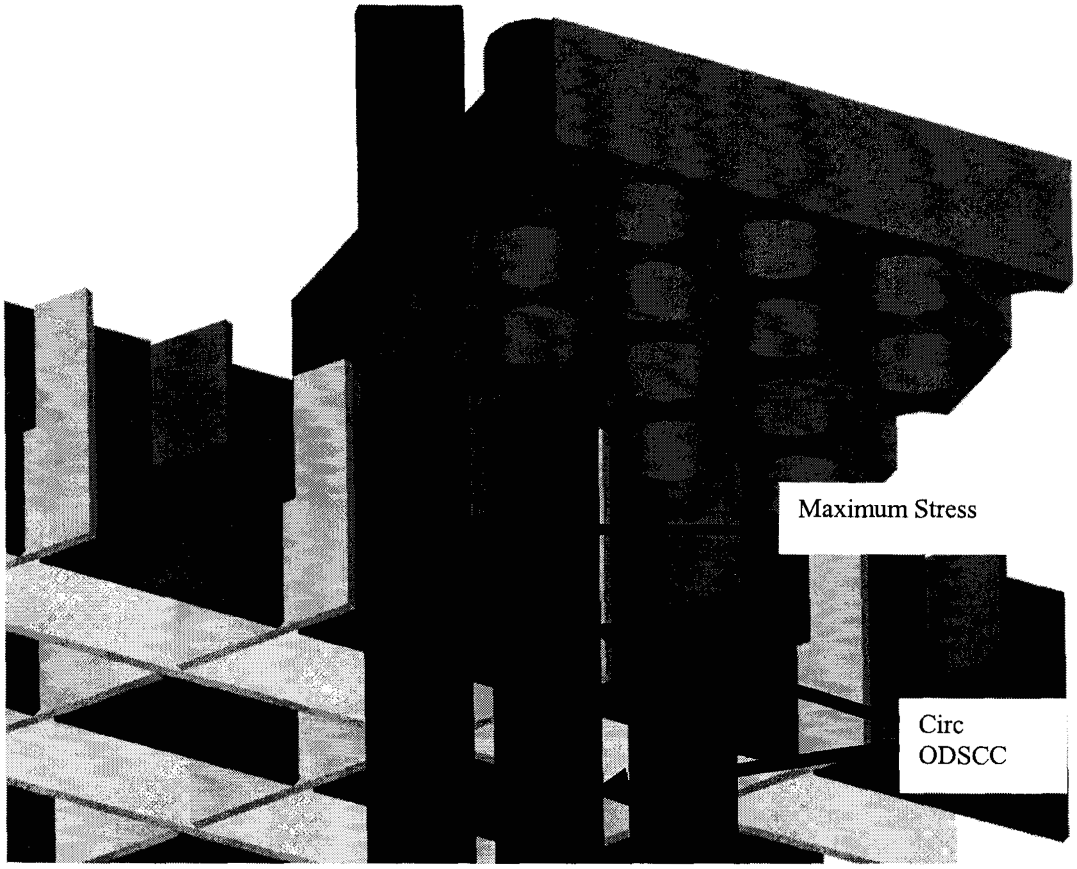
OPPD Response

A root cause analysis was conducted after the inspection. The indication identified at the eggcrate support is at the chord region (edge) of the partial drilled support plate (see UT results for SG B Row 84 Line 73 listed above in question #1). A second tube (also in the chord region) with a circumferential indication at an eggcrate location was detected in SG B (R87/L52) at support H4 – 1.10". This support structure is also a combination eggcrate / drilled plate assembly. The indication is 0.27 volts with an estimated depth of 33% and an arc length of 21 degrees. The three coil delta probe confirms the presence and orientation of the flaw. The low frequency pancake coil data shows that the flaw is located below the tube support plate and the azimuthal orientation of the flaw is about 120 degrees relative to the eggcrate lattice. Only one lattice bar is evident in the ECT data. This intersection was not included in those tested by UT.

At the top of these eggcrates along the chord the edge of the drilled plate is scalloped and has the shape of a series of semi circles when viewed from the top. Growth of the drilled plate from denting results in a bending strain at and below the eggcrate where the tube is restrained from movement in the lateral plane. This configuration is unique to the chord region and these locations have been identified as a critical area in accordance with EPRI guidelines. The February 2005 examination will include plus point coil testing of 100% of this critical area.

Eggcrate and Tube Support Plate Intersection –

Bottom View with Maximum Stress and Crack Locations



Question 6

OPPD indicated that following the outage, a review of the 2002 eddy current test results including primary, secondary, and resolution analysis performance would be conducted. Please discuss the results of this review and any effect it will have on future inspections.

OPPD Response

Following the outage each of the repairable indications was reviewed in the 2002 data set to determine whether the flaw was present and if so had it been reported by either the primary or

secondary analyst teams. Of the 107 tubes plugged for ECT indications (there were 8 more plugged to facilitate installation of the manipulator used for ECT and plugging), there were 8 indications which had been reported by both the primary and secondary analyst which had been dispositioned to NDD by the resolution team. These indications do not appear to have grown since 2002 and any change in ECT signal characteristics is judged to be within the repeatability of the technique. Two of these indications are the layered circumferential flaws at tube supports discussed in further detail below in question number 8. Discussions with some of the resolution analysts during the 2003 examination who had also participated in the 2002 inspection indicated that the apparent axial extent of the circumferential indication led them to believe that the response was not a valid flaw response. The remaining 6 indications are axial flaws, 4 of which are less than 0.35 volts and 2 of which are less than 0.77 volts in the 2003 data. The most likely reason that they were not kept in 2002 is that they were judged to be deposits rather than flaw signals.

There were another 12 indications that had been reported by either the primary or secondary analysis teams which also did not appear to have grown and which were also not considered to represent valid flaw responses by the resolution team in 2002. Six of the indications are circumferential flaws of which five are less than 0.5 volts and the sixth is 0.57 volts. It is likely that most of these were dispositioned as non-relevant based on the axial extent of these layered circumferential flaws. Five of the remaining flaws are axial indications four of which are less than 0.35 volts and one is 0.55 volts. The most likely reason that they were not kept in 2002 is that they were judged to be deposits rather than flaw signals. The last indication was a small volumetric indication at 0.32 volts which was probably judged to be a deposit in 2002.

There are another 60 indications that were not reported by either analysis team in 2002 and which do not appear to have grown. Most of these are low level axial flaws. Twenty-seven are 0.10 to 0.19 volts (2003 voltage), twenty are 0.20 to 0.29 volts, four are 0.30 to 0.39 volts, six are 0.40 to 0.49 volts, and three are 0.50 to 0.57 volts.

The remaining 27 indications were not useful in the assessment of analysis performance because they were either flaws which had changed (grown) since 2002, new flaws not present in 2002, or the 2003 test was the first inspection of the area with a plus point coil and there is no comparative data from 2002.

Examples from the 2002 data will be used in the lessons learned portion of the next data analysis indoctrination which is a required element of the FCS program. Some of the 2002 data along with an answer key will be incorporated into the raw data training materials that each analyst reviews to prepare for the site specific performance demonstration. The SSPD will also contain indications from the 2002 data set to ensure that the training materials have been understood.

Question 7

Please discuss the results from the rotating probe inspections performed in the U-bend region of rows 1-4.

OPPD Response

No flaws were detected in the 100% sample of rows 1 & 2 with the high frequency plus point coil. 20% of rows 1 & 2 were retested with the mid-frequency plus point coil as well as a 20% sample of rows 3 & 4. No flaws were reported by the mid-frequency coil either. FCS has operated with a T_{HOT} of approximately 594°F or less throughout most of the plant life. In addition, the orifice plates present from plant start-up until 1998 lowered primary coolant temperatures in the U-bend region of the first 18 tube rows to 540°F or lower. To date neither PWSCC nor ODSCC has been detected in low row u-bends at Fort Calhoun.

Question 8

In steam generator B, several indications at the eighth drilled support plate were characterized as being a series of parallel circumferential cracks. Please provide more detail on these multi-layer cracks. Include a discussion of how many parallel cracks are associated with each location. How many tubes are affected by this type of degradation? Please discuss the separation distance of these cracks and whether the proximity of one crack to the next would affect the estimated burst pressure of a single crack.

OPPD Response

During the 2003 examination a circumferential flaw with apparent unique characteristics was detected in steam generator RC-2B tube R94/C65 at the H8 support. The plus point coil measured the indication at 0.71" in axial extent and 137 degrees in circumferential extent. The indication had a signal amplitude of 1.07 volts with a maximum estimated depth of 43%. A three coil delta probe MRPC test was used to confirm and characterize the circumferential indication. The delta probe head has a conventional pancake coil and two directional coils. A comparison of the directional coil terrain maps can be used to ascertain the orientation of the flaw. The results from this test confirmed the circumferential orientation of the flaws in the drilled support plate and also indicated that there are multiple peaks present in the data which would indicate axially spaced layers of circumferential ODSCC. The shear wave transducer on the UTEC system has a smaller field of view than the plus point ECT and was able to resolve six circumferential indications within the tube support plate. No attempt was made to determine the axial spacing between these flaws, however they appear to be approximately equidistant from one another, have the similar azimuthal orientation, and are all contained within the support plate. Of the twenty-two circumferential indications reported at support locations fourteen appear to have layers of degradation while eight appear to be a single area.

The causal factor evaluation report addressed the "freespan" circumferential cracking and the layers of circumferential cracks found at drilled support H8. Drilled support plate H8 early in the life of the SGs was found to be experiencing significant volumetric expansion due to corrosion. This expansion was causing tube denting and deformation. To relieve stresses in the plate and tubes the edge supports of the plates were cut. The layers of circumferential cracking are believed to be caused by the continued volumetric expansion of the plate H8. The expansion of the plate closes the space between the plate and tube and compresses the tube. Continued volumetric growth presses the tube radially and stretches the region of the tube in contact with the plate in the axial direction as well. This displacement controlled loading is believed to be the cause of the layers of circumferential cracks. The cracks are layered in the axial direction in such a way that the imposed deformation is distributed among the cracks. This distribution results in a reduction in the axial load carried by each cracked "slice" of tubing, relative to the axial load that would be on that "slice" if it was the only crack in the tube.

The cracks are separated axially and are parallel, so they will not coalesce into a larger crack. The burst pressure is conservatively considered to be a function of the enveloping PDA which would be the collective shadow of the cracks. The possibility of a higher susceptibility to leakage due to the multiple cracks was considered. The indication with the greatest plus point voltage was leak tested and as expected no leakage resulted.