

Dave Morey
Vice President
Farley Project

Southern Nuclear
Operating Company
P.O. Box 1295
Birmingham, Alabama 35201
Tel 205.992.5131

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Docket No.: 50-348

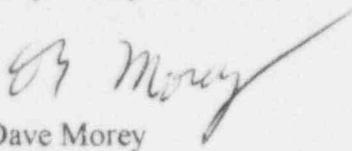
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Joseph M. Farley Nuclear Plant - Unit 1
Licensee Event Report No. 97-006-00
Steam Generator Tube Degradation and Tube Status

Ladies and Gentlemen:

Joseph M. Farley Nuclear Plant - Unit 1 Licensee Event Report No. 97-006-00 is being submitted in accordance with Technical Specification 4.4.6.5. If you have any questions, please advise.

Respectfully submitted,


Dave Morey

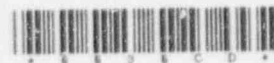
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Enclosure

cc: Mr. L. A. Reyes, Region II Administrator
Mr. J. I. Zimmerman, NRR Project Manager
Mr. T. M. Ross, Plant Sr. Resident Inspector

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ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST 500 HRS. REPORTED LESSONS LEARNED AND THE INFORMATION ENTERED INTO THE LEARNING PROCESS AND FEED BACK TO INDUSTRY, FORWARD COMMENTS REGARDING BURDEN OF DATA TO INFORMATION AND RECORDS MANAGEMENT BRANCH (7-6 P33), U.S. NUCLEAR REGULATORY COMMISSION WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET WASHINGTON, DC 20503

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EVENT DATE (5)	LER NUMBER (6)	REPORT DATE (7)	OTHER FACILITIES INVOLVED (8)
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OPERATING	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 1. (Check one or more) (11)
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

SUPPLEMENTAL REPORT EXPECTED (14)

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED	MONTH	DAY	YEAR
SUBMISSION					
DATE (15)					

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-space typewritten lines) (16)

Eddy current inspections were performed on one hundred percent of the available tubes in all three steam generators (S/G). As a result of this inspection, more than 1% of the inservice tubes in each S/G during Cycle Fourteen were found to be defective, which requires inspection results in each S/G to be classified as Category C-3. Defective indications were identified within the tubesheet, above the top of the tubesheet in the sludge pile area, at the tube support plates, and in the freespan. In addition to the required tube repair and plugging, several ongoing programs have been established to reduce the probability of future tube degradation.

**LICENSEE EVENT REPORT (LER)
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TEXT (If more space is required, use additional NRC Form 366) (17)

Plant and System Identification

Westinghouse - Pressurized Water Reactor.

Energy Industry Identification System codes are identified in the text as [XX].

Description of Event

This report is being submitted in accordance with Technical Specification 4.4.6.5.a to report the number of S/G tubes [AB] that have been plugged or repaired in each S/G, and in accordance with Technical Specification 4.4.6.5.c to report Category C-3 S/G tube inspection results, and corrective measures taken to prevent recurrence.

The results of the S/G inspections were determined to be category C-3 on April 1, 1997. The S/G tube plugging and repair was completed on May 23, 1997. During U1RF14, 149 tubes were successfully unplugged and returned to service.

Prior to the U1RF14, Southern Nuclear developed an inspection plan to inspect tubes in all three S/Gs. The inspection plan included:

- One hundred percent full length bobbin probe inspection of all available tubes
- One hundred percent plus point probe inspection of all available hot leg roll transitions.
- A 20% plus point inspection of all available cold leg roll transitions.
- Plus point inspection of all available row 1 and row 2 U-bends.
- Plus point inspection of all sludge pile and freespan indications identified by bobbin.
- Cecco probe inspection of all sleeves, both previously installed and those installed during U1RF14.
- Tube support plate (TSP) plus point inspection program required by the TSP alternate repair criteria (ARC).
- Visual inspection of all plugs.

The TSP ARC program of plus point inspections was performed on the following bobbin signals: all support plate indications greater than 2.0 volts, all dents greater than 5.0 volts, all large support plate residual signals which included all signals greater than 5.0 volts, all TSPs with interfering signals from copper deposits, and a sample of unusual phase angle signals. In addition, all tube support plate bobbin indications between 1.5 volts and 2.0 volts in S/G 1C were inspected by plus point to assist in degradation projections.

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During the TSP plus point inspection program in S/G 1A, one axial indication by plus point was identified at a TSP intersection with a dent greater than 5 volts as identified by bobbin. The inspection program was expanded to include all hot leg TSP dents in S/G 1A. During the expansion program, two additional defects were identified at TSP intersections with a dent less than 5 volts. No further expansion was required.

As a result of an indication found in the tubesheet during a 20% cold leg tubesheet plus point inspection program in S/G 1A, the program was expanded to include 100% of the critical area. No defects were identified in the expansion program.

The results of the total inspection program were screened to identify tubes whose degradation potentially exceeded thresholds where tube integrity was a potential concern for axial length, circumferential arc length, and signal amplitude. A small number of tubes were selected for inspection with combined ultrasonic and eddy current probes and in situ testing. For all degradation types, no tubes were confirmed to exceed RG 1.121 and supplemental structural and leakage integrity criteria during Cycle 14 operation.

Three tube pulls were performed to obtain additional information about Farley Nuclear Plant steam generator tubes. The three tube pulls collectively satisfy the tube pull requirements of Generic Letter 95-05. One tube was pulled for diagnostic information related to free span outer diameter stress corrosion cracking (ODSCC), one to assess long-term ODSCC progression in a plugged tube and tube integrity concerns, and one tube with a 13.7 volt TSP axial indication.

Present and past bobbin probe data were analyzed to evaluate the cracking of tube support plates which is addressed by Information Notice 96-09. Based on the bobbin probe evaluation, several tube support locations were further tested with the plus point probe. No tubes were plugged as a result of this evaluation.

There were several degradation mechanisms identified for the inservice tubes found defective during this inspection. These were: tube sheet expansion and expansion transition degradation, sludge zone degradation, free span degradation, tube support plate ODSCC, anti-vibration bar wear, stress corrosion cracking in the parent tube behind sleeves, and stress corrosion cracking in the low row U-bends.

Tube Sheet Expansion and Expansion Transition Degradation

The inspection results indicate the occurrence of an inspection transient in the expansion transition region due to the first time use of the plus point probe. During U1RF14, 29 tubes required repair due to indications below the transition and 23 tubes required repair due to indications within the transition zone.

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TEXT (if more space is required, use additional NRC Form 366) (17)

The majority of the indications below the transition were axial indications, while the indications within the transition were about half axial and half circumferential.

All active tubes in this category met RG 1.121 criteria during Cycle 14 operations and it is expected that this will be the case for Cycle 15 as well.

Sludge Zone Degradation

Outer diameter stress corrosion cracking in the sludge pile region accounted for a majority of the repairable tubes. Most of the 572 indications were axial and were located between 1 and 4 inches above the top of the tubesheet. ODSCC indications longer than 0.45 inches were subject to depth profile analysis to select UTEC and in situ pressure testing candidates. All in situ tested sludge pile region tubes met RG 1.121 structural and leakage integrity criteria.

While there has been a slight upward trend in sludge pile degradation in previous cycles, the large increase from UIRF13 to UIRF14 is considered to be an inspection transient attributed to the first time use of the plus point probe on Unit 1.

Freespan Indications

During UIRF14, 47 inservice tubes were repaired as a result of free span ODSCC. Fourteen of these tubes had indications between TSPs, while 20 tubes had indications more than 10" above the top of the tubesheet. Depth profile evaluation of tubes with indications between TSPs or more than 10" above the top of the tubesheet exhibited indications greater than 0.45 inches in length but indicated that the shallow depth of the indications did not approach the in situ testing criteria.

For indications just above top of the tubesheet, the largest reported voltage, 1.6 volts, for a free span indication exceeded the in situ test leakage screen but did not exceed the burst screen due to its short length, 0.51", and shallow depth of 60%. This indication was proof and leak tested with no burst or leakage.

Several tubes were unplugged with the plans of returning the tubes to service by sleeving. One tube had been plugged in RF9 for an indication about 7.8 volts by bobbin and located just above the tubesheet. When the tube was unplugged this refueling, the indication was 17.2 volts by bobbin. This indication was leak tested. There was no leakage at 1630 or 2554 psi, but the indication leak rate was 0.103 gpm at 2890 psi. A decision was made to pull the tube for further evaluation of the indication. Therefore the indication was not proof tested.

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TSP ODS

A total of 82 tubes required repair under the ARC criteria, including one tube in S/G A with a 6.4 volt axial indication and one tube in S/G C with a 13.7 volt axial indication. In situ testing of the 13.7 volt axial indication at pressures up to 1620 psi was conducted with no leakage observed. The estimated burst pressure for this indication is 3300 psi which is above the steam line break (SLB) pressure differential. Therefore, tube integrity would be maintained during the design basis SLB accident. A section of tube with this indication was pulled for further evaluation. The actual burst capability of this indication will be confirmed by laboratory testing.

One axial indication was identified at an intersection with a large residual bobbin signal. One axial indication was identified with a dent greater than 5 volts as identified by bobbin. All defective intersections were repaired or the tubes plugged.

Due to the one 13.7 volt axial indication, the projected SLB leak rate exceeded the previous licensed limit. However, a license amendment has been approved which increases the acceptable steam line leak rate to 19.0 gpm in the faulted loop which envelops the projected SLB leakage in S/G 1C.

AVB Wear

One tube in S/G 1C was plugged due to a 41% indication at the site of a previously repaired anti-vibration bar. There was only a slight change in the eddy current signal from RF13 and this does not represent an active degradation mechanism.

Cold Leg Pitting

Several tubes were unplugged with the plans of returning the tubes to service by the installation of sleeves on the hot leg. The tubes that were selected for recovery had only hot leg indications when originally plugged. However two tubes in S/G 1A were identified with pitting on the cold leg when unplugged. The tubes were replugged. No pitting was identified in inservice tubes.

Low Row U-Bend Cracking

Two indications were identified in row 2 tubes during the plus point inspection of the row 1 and row 2 U-bends. Two indications were identified by bobbin in row 3 tubes and confirmed by plus point. These indications did not exceed structural integrity requirements. The tubes were plugged.

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Sleeves

One tube was identified in S/G 1B with a parent tube defect behind the sleeve. One sleeve in S/G 1C was restricted and could not be inspected. Evaluation of improper sleeve installations performed during this refueling required several additional tubes to be plugged.

Tube Repair Summary	A	B	C
Inservice tubes prior to RF	3116	3223	3131
Inservice defective tubes during RF	259	209	291
Repair actions during RF	---	---	---
TSP sleeves installed during RF and left in service	110	41	88
30" TS sleeves installed during RF and left in service	1	2	3
20" TS sleeves installed during RF and left in service	293	158	296
12" TS sleeves installed during RF and left in service	1	1	2
Tubes plugged	22	39	52

Tube Status	A	B	C
Tubes inservice prior to RF	3116	3223	3131
Sleeves in service prior to RF	67	42	149
Sleeved tubes in service prior to RF	56	37	115
Percent plugging equivalent prior to RF	8.1	4.9	7.7
Tubes returned to service during RF	76	0	73
Total in service sleeves after RF	465	239	528
Total in service sleeved tubes after RF	362	204	417
Total plugged tubes after RF	214	204	229
Plugging equivalent of sleeves	24	13	27
Percent plugging equivalent after RF	7.0	6.4	7.6

The overall average percent plugging equivalent before U1RF14 of 6.9% was increased to 7.0% after U1RF14.

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ECT Defective Indication Summary for RF	A	B	C
Inservice tubes prior to RF	3116	3223	3131
Defective tubes	259	209	291
TSP ODSCC with no dents or dents < 5 volts	33	28	35
TSP ODSCC with dents > 5 volts	1	0	0
TSP ODSCC with residuals	1	0	0
TSP PWSCC	0	0	0
TSP cold leg thinning	0	0	0
AVB	0	0	1
Row 1-3 U-bends	0	2	2
Roll transition and tubesheet - +.5 inches to bottom of tubesheet	27	37	43
Above tubesheet - 0.5 inches to 10 inches ≥ TS	210	153	227
Free span - does not include above	2	16	4
Cold leg pitting - free span/tubesheet	0	0	0
Sleeves - indications in sleeves	0	0	14
Sleeves - indications in parent tube	0	1	0
Unplugged tubes during RF	---	---	---
Defective tubes	77	n/a	76
TSP ODSCC with no dents or dents < 5 volts	3	n/a	2
TSP ODSCC with dents > 5 volts	0	n/a	0
TSP PWSCC	0	n/a	0
TSP cold leg thinning	0	n/a	0
AVB	0	n/a	0
Row 1-3 U-bends	0	n/a	0
Roll transition and tubesheet - +.5 inches to bottom of tubesheet	33	n/a	20
Above tubesheet - 0.5 inches to 10 inches ≥ TS	55	n/a	65
Free span - does not include above	0	n/a	1
Cold leg pitting - free span/tubesheet	2	n/a	0
Sleeve - indications in sleeves	0	n/a	3
Sleeve - indications in parent tubes	0	n/a	0

No tubes were unplugged in S/G 1B.

Cause of Event

Investigations and evaluations performed identified several areas where tube defects were observed. These were: tube sheet and expansion transition degradation, sludge zone degradation, free span degradation, AVB wear, low row U-bend degradation, and tube support plate ODSCC.

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Reportability Analysis and Safety Assessment

This event is being reported in accordance with Technical Specifications 4.4.6.5.a and 4.4.6.5.c. A condition monitoring and operational assessment has been completed addressing the safety significance of Cycle 14 and Cycle 15 operation of Farley Unit 1 with the various types of localized tube wall degradation occurring in the steam generator tubing. Steam generator C was found to be the limiting SG for Cycle 14 operation and is projected to be the limiting steam generator for Cycle 15 operation. Calculations show that the voltage based repair criteria at end of Cycle 14 will satisfy the NRC criteria for allowable leakage and burst capability. Likewise, it is concluded that Cycle 15 operation of Farley Unit 1 will continue to meet the required acceptance criteria.

Corrective Action

The S/G tubes have been plugged or repaired as required. In addition, the following actions are continuing in order to reduce the probability of future tube degradation:

1. A program of secondary side boric acid addition which was begun in 1983 is being continued to reduce the potential for ODSCC.
2. Several secondary side chemical addition programs have been initiated to reduce the potential for sludge accumulation. A program of morpholine addition was begun in 1988. Hydrazine addition to the feedwater system was increased in 1993. Monoethanolamine (ETA) addition was started in 1993.
3. The Westinghouse sludge lance cleaning process was initiated during the First Refueling in all three S/Gs to remove contaminants from the top of the tubesheet area.
4. The Westinghouse pressure pulse cleaning program was initiated during the Eighth Refueling in all three S/Gs to remove contaminants from the crevices between the tubes and support plates.
5. The Westinghouse U-bend heat treat process was performed on all Row 1 and 2 tubes in service during U1RF10 to reduce the potential of U-bend SCC.
6. During the Unit 1 Fifth and Sixth Refueling Outages, many of the secondary components containing copper were replaced with components containing stainless steel.

The following actions have recently been initiated to further reduce the probability of future tube degradation:

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1. Dimethylamine (DMA) was added during the pressure pulse cleaning process in all three steam generators during this refueling to aid in the reduction of copper and silicates.
2. An aggressive program of S/G wet layup with carbohydrazide was initiated during this refueling to help reduce corrosion.

Additional Information

Similar events were reported in LERs 86-004-00(Unit 2), 87-004-02(Unit 2), 90-005-01(Unit 2), 93-003-00(Unit 2), 94-002-00(Unit 1), 95-001-01(Unit 2), 95-009-00(Unit 1), and 96-008-00(Unit 1).

On April 11, 1997, Southern Nuclear (SNC) made a conservative 50.72 non-emergency Four Hour Report concerning S/G 1C tube R2C85 as not meeting the margin required by RG 1.121. SNC has subsequently determined that the large voltage indication is not reportable under 50.72. This is based on this indication in combination with the other tube support indications that were found in S/G 1C meeting the probability of tube burst and steam line break leakage criteria of the alternate repair criteria for ODSCC at tube support plate intersections. In addition, the estimated burst pressure for tube R2C85 was determined to be above the steam line break differential pressure. Therefore, tube integrity would be maintained during the design basis SLB accident. A portion of tube R2C85 including the 13.7 volt indication has been removed from the S/G. The actual burst capability of this tube at the intersection will be confirmed by laboratory testing.

A follow-up report concerning additional information on tube R2C85 was provided to the NRC by SNC letter dated May 13, 1997.