

December 28, 1999

Mr. D. N. Morey  
Vice President - Farley Project  
Southern Nuclear Operating  
Company, Inc.  
Post Office Box 1295  
Birmingham, Alabama 35201-1295

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SUBJECT: JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1 RE: STEAM GENERATOR  
INSPECTION 90-DAY REPORT REVIEW (TAC NO. MA5116)

Dear Mr. Morey:

Your letter of March 16, 1999, submitted your steam generator 90-day report, "Farley Unit 1 1999 Voltage-Based Repair Criteria 90 Day Report" to us. You submitted the report in accordance with Generic Letter 95-05 as a result of implementing the voltage-based alternate repair criteria in the Joseph M. Farley Unit 1 Technical Specifications.

The amendment approving the use of voltage-based repair criteria for Unit 1 included a reporting threshold of  $1 \times 10^{-2}$  for the conditional probability of tube burst. You estimated a conditional burst probability below this threshold using an NRC staff-approved methodology. The estimates of the primary-to-secondary leak rate during a postulated main steamline break for Farley Unit 1 were below the allowable main steamline break leak rate of 23.8 gpm also using an NRC staff-approved methodology. We conclude that your predictive methodology is providing adequate results. Enclosed is our review of your 90-day report. Please contact me at (301) 415-1423 if you have any questions about this.

Sincerely,

Original signed by:

L. Mark Padovan, Project Manager, Section 1  
Project Directorate II  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket No. 50-348

Enclosure: As stated

cc w/encl: See next page

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

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Sincerely,

A handwritten signature in black ink, appearing to read "L. Mark Padovan".

L. Mark Padovan, Project Manager, Section 1  
Project Directorate II  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

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cc w/encl: See next page

Joseph M. Farley Nuclear Plant

cc:

Mr. L. M. Stinson  
General Manager -  
Southern Nuclear Operating Company  
Post Office Box 470  
Ashford, Alabama 36312

Rebecca V. Badham  
SAER Supervisor  
Southern Nuclear Operating Company  
P. O. Box 470  
Ashford, Alabama 36312

Mr. Mark Ajluni, Licensing Manager  
Southern Nuclear Operating Company  
Post Office Box 1295  
Birmingham, Alabama 35201-1295

Mr. M. Stanford Blanton  
Balch and Bingham Law Firm  
Post Office Box 306  
1710 Sixth Avenue North  
Birmingham, Alabama 35201

Mr. J. D. Woodard  
Executive Vice President  
Southern Nuclear Operating Company  
Post Office Box 1295  
Birmingham, Alabama 35201

State Health Officer  
Alabama Department of Public Health  
434 Monroe Street  
Montgomery, Alabama 36130-1701

Chairman  
Houston County Commission  
Post Office Box 6406  
Dothan, Alabama 36302

Resident Inspector  
U.S. Nuclear Regulatory Commission  
7388 N. State Highway 95  
Columbia, Alabama 36319



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

REVIEW BY THE OFFICE OF NUCLEAR REACTOR REGULATION

OF THE STEAM GENERATOR 90-DAY REPORT

JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1

SOUTHERN NUCLEAR OPERATING COMPANY

DOCKET NO. 50-348

1.0 INTRODUCTION

Southern Nuclear Operating Company's (SNC's) letter of March 16, 1999, submitted a report for Joseph M. Farley Nuclear Plant Unit 1 (Farley 1), "Farley Unit 1 1999 Voltage-Based Repair Criteria 90 Day Report." SNC submitted the report for staff review in accordance with Generic Letter (GL) 95-05 as a result of implementing the voltage-based alternate repair criteria in the Farley-1 Technical Specifications (TS).

GL 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," allows steam generator (SG) tubes having outside diameter stress corrosion cracking (ODSCC) that is predominately axially oriented and confined within the tube support plates to remain in service on the basis of, in part, bobbin coil voltage response. GL 95-05 specifies that utilities should submit inspection results and associated tube integrity analyses within 90 days of each plant restart following an SG tubing inspection. The report should include, at a minimum, the projected end-of-cycle (EOC) calculations for voltage distribution and the associated tube leakage and tube burst probability under main steamline break (MSLB) conditions.

2.0 GENERAL PLANT DESCRIPTION

Farley-1 has been operating since 1977 and has three Westinghouse Model 51 SGs. The tubes are  $\frac{7}{8}$ -inch diameter and were fabricated from mill-annealed alloy 600. The SGs have drilled hole carbon steel tube support plates (TSPs).

On March 24, 1997, the staff approved a permanent change to SNC's TS which incorporated an SG voltage-based alternate repair criteria in accordance with GL 95-05. SNC used a lower repair limit of 2.0 volts and determined an upper repair limit (URL) of 5.6 volts.

The alternate repair criteria can be applied to ODSCC at the TSP intersections. The amendment allows SNC to leave indications in service having bobbin indications less than or equal to 2.0 volts. Indications that are measured to be less than the URL and greater than 2.0 volts are inspected with a rotating pancake coil (RPC) probe. If the RPC examination confirms degradation, those tubes are then plugged or repaired. Any indication greater than the URL are plugged or repaired regardless of the RPC response.

### 3.0 STAFF ASSESSMENT

#### 3.1 Inspection Scope and Results

In accordance with the alternate repair criteria (ARC) guidance provided in GL 95-05, SNC's EOC-15 inspection of the Farley-1 SGs consisted of a complete, 100 percent eddy current (EC) bobbin probe, full-length examination of the tube bundles in all three SGs. SNC used a 0.720-inch diameter bobbin probe for all hot and cold leg TSPs where the voltage-based repair criteria were applied. SNC performed an RPC examination for all tube support plate bobbin indications greater than 2 volts. A total of 3502 ODSCC indications were identified at TSP intersections. A total of 1399 indications were above 1 volt and 107 exceeded 2 volts. A total of 469 indications (including the 107 indications over 2 volts) were RPC inspected and 436 were confirmed as flaws.

SNC plugged SG tubes to remove a total of 339 indications from service, including 101 indications with ODSCC at TSPs. The rest of the indications are in tubes plugged for degradation mechanisms other than ODSCC at TSPs.

Based on the number of indications returned to service for BOC-16, SG C is considered to be the limiting SG for cycle 16 operation. As discussed in Section 3.3.3 of this review, this conclusion is supported by the calculated estimate of accident tube leakage.

#### 3.2 Evaluation of Probabilistic Methodologies for Estimating Conditional Probability of Burst and Total Leak Rate Under Postulated Steam Line Break Conditions

Acceptable tube integrity at the conclusion of cycles 15 and 16 is demonstrated, in part, by 1) a calculated conditional probability of tube burst under MSLB for the limiting SG which is less than the reporting threshold indicated in GL 95-05 and 2) an estimated accident-induced SG tube leak rate from ODSCC at tube support plate intersections below plant-specific reporting thresholds. Three distinct probabilistic calculations are necessary to determine these results. The following summarizes the staff's evaluation of the results reported on these calculations.

##### 3.2.1 Projected End-of-Cycle Voltage Distribution

SNC's 90-day report compared the as-found distribution of voltages from the EOC-15 refueling outage inspection to those estimated from the predictions made following the prior outage inspection (EOC-14). The EOC-15 projections are based on a constant probability of detection of 0.6. SG C was predicted to be the limiting SG for EOC-15, which is consistent with the inspection results for EOC-15. SGC had the highest number of indications as well as the largest indication at EOC-15.

In order to obtain the most conservative results with respect to the growth rate distribution used in Monte Carlo simulation, SNC considered SG specific growth rate distributions obtained from operation in cycles 14 and 15. GL 95-05 recommends that the more conservative growth distribution from the last two cycles be used for projecting EOC distributions for the next operating cycle. The data from the last two operating cycles (cycles 14 and 15) shows the growth rates for cycle 15 are more limiting. Therefore, SNC applied the cycle 15 growth data to obtain EOC-16 projections. The cycle 15 growth rate distribution for SG A is higher than the

composite growth rate distribution and, per the recommended methodology, the SG specific growth rate is used for SG A. The cycle 15 growth rate for SGs B and C are below the composite growth rate; therefore, the composite growth rate is applied to those SGs to provide a conservative basis for predicting the EOC-16 conditions.

Using the inspection findings in the EOC-15 inspection and the appropriate probability distribution function of growth rates, SNC calculated the projected EOC-16 voltage distribution for bobbin coil probe TSP indications.

### 3.2.2 Conditional Probability of Tube Burst During an MSLB

Following the EOC-14 refueling outage, SNC estimated the EOC-15 burst probabilities for the three SGs. SNC projected the burst probabilities to be  $2.5 \times 10^{-3}$ ,  $2.2 \times 10^{-3}$ , and  $9.9 \times 10^{-3}$  for SGs A, B, and C, respectively. Using the actual inspection results as the input into the calculations for tube burst, SNC determined the as-found conditional burst probabilities to be  $7.5 \times 10^{-4}$ ,  $7.3 \times 10^{-4}$ , and  $2.2 \times 10^{-3}$ . Therefore, the predictive methodology used by SNC provided conservative results. GL 95-05 specifies a reporting threshold of  $1 \times 10^{-2}$ . SNC's calculated and as found burst probabilities for all three SGs are below the reporting threshold.

Following GL 95-05 guidance, SNC reported the projected EOC-16 conditional tube burst probabilities. SNC determined the calculated probability of tube burst for SGs A, B, and C to be  $2.9 \times 10^{-3}$ ,  $1.5 \times 10^{-3}$ , and  $5.6 \times 10^{-3}$ , respectively. SNC's projected values are well below the GL reporting threshold of  $10^{-2}$ , and therefore, the estimated tube burst probability due to ODSCC at tube support plates is within acceptable limits for cycle 16 operation.

### 3.2.3 Steamline Break Leak Rate Projection

The staff evaluated the MSLB leak rate reported by SNC in a manner similar to the evaluation of the conditional tube burst probabilities. Although a voltage-dependent leak rate correlation can now be applied to  $\frac{7}{8}$ -inch diameter tubing, SNC obtained the actual EOC-15 voltages assuming leak rate is independent of bobbin voltage so that they can be compared with the projections performed at the BOC-15 (which also used voltage independent leak rates). For SGs A, B, and C, the EOC-15 projected leak rate was previously estimated to be 7.9, 6.9, 11.4 gallons per minute (gpm) (equivalent volumetric rate at room temperature), respectively. The estimate based on inspection results obtained during the EOC-15 outage are 4.7, 3.4, 5.3 gpm (equivalent volumetric rate at room temperature). All values for cycle 15 are much smaller than the Farley 1 MSLB leak rate limit of 23.8 gpm equivalent volumetric rate at room temperature. SNC projects the EOC-16 MSLB leak rates for SGs A, B, and C to be 6.7, 5.1 and 8.2 gpm respectively at room temperature using a leak rate correlation developed for  $\frac{7}{8}$ -inch diameter tubing. SNC's values are smaller than the Farley 1 reporting threshold limit of 23.8 gpm (equivalent volumetric rate at room temperature) and are acceptable.

### 3.3 Database for Tube Integrity Calculations

In order to calculate the conditional tube burst probabilities and postulated MSLB primary-to-secondary leak rate, the methodology approved in GL 95-05 requires using burst and leak rate data obtained from model boiler tubes and tubes removed from actual SGs. The industry has developed correlations relating bobbin coil voltage to the measured leak rate, probability of

burst, and burst pressure through the testing of these tubes. The database used for the alternate repair criteria correlations that were applied in SNC's analyses was consistent with that considered in the staff's safety evaluation of March 24, 1997, applicable to Farley Unit 1. The database is also consistent with the industry methodology for including new data which the NRC has reviewed and found to be acceptable. Therefore, the staff finds the ARC correlations utilized by SNC acceptable.

### 3.4 Tube Pull Results

GL 95-05 requires periodic tube specimen removals to monitor the morphology of ODS/CC degradation at tube support plate intersections and to obtain additional data for inclusion in the correlations relating bobbin coil voltage amplitude to tube burst pressure, probability of leakage, and leak rate. SNC removed tubes during the previous outage. Therefore, SNC was not required to remove tubes during the EOC-15 outage. The staff previously reviewed SNC's results from the tubes pulled during the EOC-14 outage.

### 3.5 Probe Wear Criteria

SNC used an alternative method to evaluate probe wear as opposed to the method outlined in GL 95-05. NEI developed the alternative method and the NRC staff found it to be acceptable as discussed in Brian Sheron's NRC letter of March 18, 1996, to Alex Marion of the NEI. Farley 1 was given approval to use this alternative method in the staff's safety evaluation for the voltage-based alternate repair criteria amendment of March 24, 1997.

The alternative approach is such that if the amplitude from the probe wear standard prior to probe replacement exceeds the  $\pm 15$  percent wear limit, all tubes with voltage responses measured at 75 percent or greater of the lower voltage repair limit (2 volts) must be reinspected with a bobbin probe satisfying the  $\pm 15$  percent wear standard criterion. The voltages from the reinspection are used as the basis for tube repair.

At the EOC-15 inspection, Farley 1 used the alternate probe wear criteria. All tubes with indications greater than 75 percent of the lower voltage repair limit (2 volts) were reinspected with a probe which satisfied the probe wear criterion. SNC evaluated the alternative approach and concluded it was adequate. SNC compared voltages measured with a worn probe and a new probe at the same locations. No indications had gone undetected by a worn probe and no pluggable tube indications were missed by a worn probe.

## 4.0 CONCLUSION

The projected EOC-16 conditional probability of burst and projected leak rate under postulated MSLB conditions were less than the GL 95-05 criteria. The staff has reviewed and concludes the predictive methodology used by SNC is providing adequate results.

Principal Contributor: A. Keim

Date: December 28, 1999