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SUBJECT: Forwards response to GL-95-03, "Circumferential Cracking Of Steam Generator Tubes."

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P.O. Box 128, Ft. Pierce, FL 34954-0128

FPL

June 23, 1995

L-95-174
10 CFR 50.4
10 CFR 50. 54 (f)

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

RE: St. Lucie Units 1 and 2
Docket No. 50-335 and 50-389
Generic Letter 95-03 Response

Attachment 1 is the Florida Power and Light Company (FPL) response to Generic Letter 95-03 "Circumferential Cracking of Steam Generator Tubes" for St. Lucie Units 1 and 2. Attachment 2 is Electric Power Research Institute (EPRI) Letter from C.S. Welty to C. Calloway (NEI) dated May 26, 1995, *EPRI Input on NDE/ISI of SG Tube Circumferential Cracking*, which is referenced in our response.

The Generic Letter provided notification of recent Steam Generator tube inspection findings at Maine Yankee and discusses the safety significance of these findings. Licensees were requested to confirm plans to implement the recommended actions and submit a written response. The response was to include a safety assessment justifying continued operation based on the evaluations performed; and a summary of the plans and schedules for the next inspections.

The attached information is provided pursuant to the requirements of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f).

Please contact us if there are any questions about this submittal.

Very truly yours,

D. A. Sager
Vice President
St. Lucie Plant

DAS/GRM

Attachments

cc: Stewart D. Ebneter, Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, St. Lucie Plant

A001 1/1

St. Lucie Units 1 and 2
Docket No. 50-335 and 50-389
Generic Letter 95-03 Response

STATE OF FLORIDA)
) ss.
COUNTY OF ST. LUCIE)

D. A. Sager being first duly sworn, deposes and says:

That he is Vice President, St. Lucie Plant for the Nuclear Division of Florida Power & Light Company, the Licensee herein;

That he has executed the foregoing document; that the statements made in this document are true and correct to the best of his knowledge, information and belief, and that he is authorized to execute the document on behalf of said Licensee.

D. A. Sager

STATE OF FLORIDA
COUNTY OF ST. LUCIE

The foregoing instrument was acknowledged before me this 23 day of June, 19 95 by D. A. Sager, who is personally known to me and who did take an oath.

Karen West

KAREN WEST
Name of Notary Public

My Commission expires 4-18-98

Commission No. CC 359926

KAREN WEST
MY COMMISSION # CC359926 EXPIRES
April 18, 1998
BONDED THRU TROY FAIN INSURANCE, INC.

St. Lucie Units 1 and 2
Docket No. 50-335 and 50-389
Generic Letter 95-03 Response

REQUESTED ACTION 1

Evaluate recent operating experience with respect to the detection and sizing of circumferential indications to determine the applicability to their plant.

FPL RESPONSE

Utility owner group and NSSS operating experience data was compiled and reviewed via industry wide surveys conducted by Nuclear Energy Institute (NEI). Circumferential cracking has been reported in twelve of fifteen operating units with Combustion Engineering (CE) design steam generators (SG) in the past five years. This includes St. Lucie Units 1 & 2. Circumferential cracks resulted in tube leaks at four units since 1983. No tube leaks have occurred at St. Lucie Units 1 or 2 due to circumferential cracks.

In currently operating CE SGs, all reported circumferential cracks are located at the tube expansion transition at the top of the hot leg tubesheet. No circumferential cracks have been reported at the tube expansion transition on the cold leg side, or at other locations. Both outside diameter (ODSCC) and inside diameter stress corrosion cracking (PWSCC) have been reported in operating CE SGs.

In retired CE SGs at two units, only ODSCC was reported. Cracking at one unit was limited to the tube expansion transition, but was reported on both hot leg and cold leg sides. Cracking at the other unit was reported on the hot leg side at tube support plate intersections and in the u-bend.

Severity of circumferential cracking in CE SGs can be assessed from metallurgical examination of pulled tubes and in-situ pressure testing. Fifteen tubes have been removed from CE SGs for circumferential cracking. In addition, thirty-two tubes at four units have been in-situ pressure tested. The available data from these tube pulls and in-situ pressure tests indicate that structural limits have not been violated (Attachment 2).

REQUESTED ACTION 2

On the basis of the evaluation in Action 1 above, past inspection scope and results, susceptibility to circumferential cracking, threshold of detection, expected or inferred crack growth rates, and other relevant factors, develop a safety assessment justifying continued operation until the next scheduled steam generator tube inspections are performed.

FPL RESPONSE

It has been FPL's philosophy to perform full length bobbin coil inspection of all active tubes at each inspection since 1984 at the St. Lucie Plant. The examinations utilized bobbin coil techniques with digital multi-frequency instrumentation. In addition, conventional motorized rotating pancake coil (MRPC) techniques are routinely used to further characterize selected bobbin indications. After review and evaluation by industry groups and FPL, new technology has been routinely phased in at St. Lucie in accordance with Reference 1 to provide a link to prior examination data. The scope and results of the past three inspections at St. Lucie Units 1 & 2 are summarized below.

ST. LUCIE UNIT 1 PAST INSPECTION SCOPE & RESULTS

END OF CYCLE	FULL LENGTH BOBBIN EXAM	HL MRPC EXAMS[1]	CL MRPC EXAMS[1,2]	# HL CIRC. INDICATIONS[1]
EOC 10	100%	100%	3%	98
EOC 11	100%	100%	3%	12
EOC 12	100%	100%	3%	14

1 - MRPC examinations & Circ. Indications are at the tube expansion transition.
2 - Cumulative inspections have examined 6.3% of cold leg tube expansion transitions.

ST. LUCIE UNIT 2 PAST INSPECTION SCOPE & RESULTS

END OF CYCLE	FULL LENGTH BOBBIN EXAM	HL MRPC EXAMS[1]	CL MRPC EXAMS[1]	# HL CIRC. INDICATIONS[1]
EOC 5	100%	0%	0%	0
EOC 6	100%	0%	0%	0
EOC 7	100%	100%	3%	2

1 - MRPC examinations & Circ. Indications are at the tube expansion transition.

In addition to the above inspections, a sample of between 7% and 14% of the total hot leg dented support plate intersections was also inspected with MRPC techniques at EOC 11 & 12 at St. Lucie Unit 1. No circumferential cracks were detected.

Threshold of Detection - Conventional MRPC technology is qualified to Appendix H of the EPRI "PWR Steam Generator Examination Guidelines" (Reference 1) for detection of ODSCC and PWSCC. This qualification requires that a technique demonstrate, at a minimum, a probability of detection (POD) of 0.80 at a 0.90 confidence level (CL) for

flaws 60% or greater through wall on a suitable specimen set as defined by table S2-2 of Appendix H. The actual performance of conventional MRPC for detection of circumferential cracks based on field data for a pulled tube specimen set is a POD of 83% at a 90% CL (Attachment 2).

Growth Rates - These inspection results show that relatively few circumferential cracks have been detected in the St. Lucie SGs. In addition, MRPC results demonstrate that the number of defects identified after the initial 100% MRPC inspection at the top of the tubesheet have leveled off to approximately 14 per inspection. Qualitative comparison of the St. Lucie MRPC results with similar results from tubes that have been examined metallurgically or in-situ pressure tested indicate that the St. Lucie defects were identified early in their lifetimes and were not of sufficient size to threaten mid-cycle leakage.

Continued operation until the next scheduled SG inspection for St. Lucie Units 1 & 2 is justified based on the inspections conducted and the results obtained as reviewed above. These inspections meet or exceed St. Lucie Plant Technical Specifications and EPRI PWR Steam Generator Examination Guidelines (Reference 1). Conventional MRPC techniques have been qualified for detection of circumferential cracking under Appendix H of Reference 1 since 1992. In addition, available pulled tube and in-situ pressure test data provided by utility owners groups and NSSS vendors indicate that structural limits have not been violated.

In addition, St. Lucie maintains a stringent water chemistry program in accordance with industry standards to mitigate tube degradation. The SGs are monitored closely for leakage during operation and shutdown periods. St. Lucie has not plugged any tubes as a result of leakage due to corrosion since 1984. Operators are trained to identify conditions which may indicate a SG tube leak. In the event that a tube leak occurs, St. Lucie has operator training programs, simulator exercises, and procedures in place to mitigate the consequences of failed tubes.

REQUESTED ACTION 3

Develop plans for the next steam generator tube inspections as they pertain to the detection of circumferential cracking. The inspection plans should address, but not be limited to, scope (including sample expansion criteria, if applicable), methods, equipment, and criteria (including personnel training and qualification).

FPL RESPONSE

FPL's philosophy has been to perform full length bobbin coil inspection of all active tubes at each inspection since 1984 at the St. Lucie Plant. Conventional motorized rotating pancake coil (MRPC) techniques are also routinely used to further characterize selected bobbin indications. The scope of future inspections (including sample expansion criteria), methods, equipment, and criteria for personnel training and qualification at St. Lucie Unit 1 & 2 will be conducted, as a minimum, in accordance with the examination protocol established in the PWR Steam Generator Examination Guidelines (Reference 1). Current plans include conventional MRPC examination for 100% of active hot leg tube expansion transitions and 3% of cold leg tube expansion transitions. Examinations for cold leg tube expansion transitions are concentrated in regions where cracking has been detected on the hot leg side. Upon completion of review and evaluation by industry groups and FPL, new technology has been routinely phased in at St. Lucie in accordance with Reference 1 to provide a link to prior examination data. Examination techniques which demonstrate further improvement in detection capability may be implemented when a qualified sizing technique or alternate plugging criteria (APC) for circumferential cracks is also available.

REQUESTED INFORMATION ITEM 1

Submit a safety assessment justifying continued operation that is based on the evaluations performed in accordance with Requested Actions (1) and (2) above.

FPL RESPONSE

Continued Operation is justified based on inspections conducted for St. Lucie Units 1 & 2 and the results obtained as reviewed below. These inspections meet or exceed St. Lucie Plant Technical Specifications and EPRI PWR Steam Generator Examination Guidelines (Reference 1). Reference 1 provides a protocol for developing and applying technology to manage existing and emerging damage forms, including circumferential cracking. Conventional MRPC techniques have been formally qualified since 1992 for detection of circumferential cracking. Field tube pull data indicate that, for circumferential cracks, the performance exceeds the minimum requirements of Appendix H of Reference 1. Experience data provided by the utility owners groups and NSSS vendors indicate that this technology and protocol have adequately managed circumferential cracking. This is supported by: (1) the recent tube leak at Maine Yankee in July 1994 was due to a "missed" indication from a previous inspection and (2) available pulled tube and in-situ pressure test data indicate that structural limits have not been violated (Attachment 2).

In addition, St. Lucie maintains a stringent water chemistry program in accordance with industry standards to mitigate tube degradation. The SGs are monitored closely for leakage during operation and shutdown periods. St. Lucie has not plugged any tubes as

a result of leakage due to corrosion since 1984. Operators are trained to identify conditions which may indicate a SG tube leak. In the event that a tube leak occurs, St. Lucie has operator training programs, simulator exercises, and procedures in place to mitigate the consequences of failed tubes.

REQUESTED INFORMATION ITEM 2

Submit a summary of the inspection plans developed in accordance with Requested Action (3) and a schedule for the next planned inspection.

FPL RESPONSE

It has been FPL's philosophy to perform full length bobbin coil inspection of all active tubes at each inspection since 1984 at the St. Lucie Plant. In addition, conventional motorized rotating pancake coil (MRPC) techniques are routinely used to further characterize selected bobbin indications. The scope of future inspections (including sample expansion criteria), methods, equipment, and criteria for personnel training and qualification at St. Lucie Unit 1 & 2 will be conducted, as a minimum, in accordance with the examination protocol established in the PWR Steam Generator Examination Guidelines (Reference 1). Current plans for scope and outage schedule for the next inspections are summarized below. These schedules may change as conditions warrant.

ST. LUCIE UNIT 1 & 2 NEXT INSPECTION - SCOPE & SCHEDULE

UNIT / SG	OUTAGE DATE	BOBBIN EXAMS	HL MRPC EXAMS[1]	CL MRPC EXAMS[1]
1A	4/96	100%	100%	3%
1B	4/96	100%	100%	3%
2A	10/95	100%	100%	3%
2B	10/95	100%	100%	3%

1 - MRPC examinations are at the tube expansion transition.

Upon completion of review and evaluation by industry groups and FPL, new technology has been routinely phased in at St. Lucie in accordance with Reference 1 to provide a link to prior examination data. Examination techniques which demonstrate further improvement in detection capability may be implemented when a qualified sizing technique or alternate plugging criteria (APC) for circumferential cracks is also available.

Reference:

1. PWR Steam Generator Examination Guidelines, Revision 3 EPRI Report NP-6201, November 1992.

EPRI
Electric Power
Research Institute *Leadership in Electrification through Global Collaboration*

May 26, 1995

Mr. R. Clive Callaway
Project Manager
Nuclear Energy Institute
1776 Eye Street, N.W., Suite 300
Washington, DC 20006-3708

Subject: Response to NRC Generic Letter 95-03, EPRI Input on NDE/ISI of SG Tube Circumferential Cracking

Dear Clive:

Attached is the EPRI input to the industry effort in support of the required response to NRC Generic Letter 95-03. The information is consistent with the current version of the "PWR Steam Generator Examination Guidelines" (Revision 3, 11/92), and reflects available industry practices. It is provided as reference material to be used by the utilities in developing responses to the Generic Letter.

Please contact me if you have any questions.

Sincerely,

C. S. Welty, Jr.
Manager, Steam Generator Program

cc: SGMP Utility Steering Committee

NDE/ISI for Circumferential Cracking

May 19, 1995

The material below is provided to assist PWR operating utilities in preparing their response to NRC Generic Letter (G/L) 95-03, "Circumferential Cracking of Steam Generator Tubes". The material is provided in response to an action item from a May 9, 1995 meeting held under the auspices of the NEI Steam Generator Issues Working Group wherein the following three-point strategy for responding to the G/L was developed:

1. EPRI to document the current status of MRPC qualification relative to detection of circumferential cracks (including current specific POD and confidence level), and provide information to assist in responding to Item 3 of G/L 95-03 regarding future inspection plans based on Revision 3 of the PWR Steam Generator Examination Guidelines;

2. Each Owners Group and/or NSSS supplier to provide a compilation of recent operating experience relative to circumferential cracking (e.g., # of cracks as a function of location and EFPY, tube pull results, in-situ pressure test results, etc.);

3. Each utility to use the information provided in 1. and 2. to develop a plant specific response to G/L 95-03.

ISI Recommendations

Current recommendations relative to ISI effectiveness are based on conformance to the "PWR Steam Generator Examination Guidelines" (EPRI Report NP-6201, Revision 3, November, 1992). "Conformance" includes having a management/administrative structure that is responsible for implementing the "Steam Generator Examination Engineering" functions described in Section 2, Responsibility, of the Guidelines. Additionally, conformance leads to application of specific portions of Sections 3 and 4 (Guidelines Summary and Steam Generator Examination - Recommended Practice, respectively) that address, at a minimum, the following:

1. A "random" inspection sample scope (i.e., 20% tube-end-to-tube-end bobbin coil examination of all generators) and expansion rules;

2. An "augmented" inspection sample which factors in experience at the particular unit being inspected as well as other relevant industry experience;

3. The use of techniques that are qualified to Appendix H for the particular damage forms that might exist/be found during a specific inspection outage;

4. Data analysis, including;
   a. use of Qualified Data Analysts (QDAs);
   b. development and use of site-specific analysis guidelines;
      1. including the attached guidance "Points to Consider in Circumferential Crack Detection and Length Sizing" (2/21/95)
   c. use of site specific pre-ISI performance demonstration;
   d. analysis of all data;
   e. independent two-party review of data;

5. The use of supplemental NDE techniques and procedures to resolve anomalous/unexpected ISI results.

1. Tubesheet Expansion Zone Region (Including Top of Tubesheet [TTS])

The following discussion applies to the augmented ISI for expansion zone and TTS circumferential cracking. Since all TS expansion designs (explosive, hard-roll and hydraulic) in plants with mill-annealed (non-thermally treated) alloy 600 tubing have exhibited such cracking, both OD and ID initiated and in some cases with as little as ~2 EFPY, it would be expected that all plants with such material and expansion designs inspect a minimum of 20% of the HL transitions in each SG with "conventional" MRPC technology (see NDE Technique Qualification below). If cracking is found in the, the inspection scope should be expanded to 100% in the HL. (If HL cracking is widespread, or if comparison to industry experience indicates that the onset of the problem in the CL is imminent, a 20% CL sample should be done.) If there are geometric discontinuities beyond those found in "normal" transitions, supplemental techniques appropriate to the circumstances should be used to augment the conventional MRPC examination. (Note: absence of "formal" Appendix H qualification should not be considered an obstacle to the use/application of new and developing technologies and procedures [e.g., use of different diameter ECT coil, the use of new probes, etc.].)

2. Dented Support Intersections

For plants with dented tube support intersections (eddy current indications greater than 5 volts), the above discussion relative to techniques, initial augmented sample and expansion to 100% of the dented region (intersections greater than 5 volts) if cracking is found applies (unless the plant is governed by use of interim tube plugging criteria and inspection requirements consistent with Generic Letter 95-XX). The initial 20% augmented sample can be confined to the lowest HL support, applies only to those intersections with

>5 volt dents, and need only be expanded if cracking is found in that region. It should be noted that dents generally imply substantial geometric discontinuities where the application of supplemental technologies would be recommended.

3. Inner-row U-bends

For plants with tubing susceptible to inner-row (small radius) U-bend PWSCC, 100% of the susceptible population should be examined with conventional MRPC technology until/unless U-bend stress relief has been applied in which case a 20% initial sample may be applied (note: conventional MRPC coil[s] are generally configured on a special probe to allow passage through the U-bend region). If cracking is found the sample should be expanded to 100% of the susceptible tubes.

4. Sleeved Tubes

For plants with sleeved tubes, 20% of the HL sleeved tubes should be examined to verify the integrity of the sleeve-to-tube joint(s). If cracking is found the sample should be expanded to 100% of the HL sleeved tubes. (For plants with CL sleeves, if HL sleeve cracking is widespread, or if comparison to industry experience indicates that the onset of the problem in the CL sleeves is imminent, a 20% sample of CL sleeves should be done.) Since the sleeve-to-tube joint generally presents a substantial geometric discontinuity one of the supplemental technologies is recommended for this inspection. At least two of these (the Cecco probe and the Plus Point probe/coil) are currently undergoing peer review for formal qualification to the requirements of Appendix H of the Examination Guidelines, and are expected to be formally qualified by the end of May 1995 (see discussion on technique qualification below).

<u>NDE Technique Qualification</u>

Currently (May 19, 1995) conventional MRPC technology is qualified to Appendix H of the "PWR Steam Generator Examination Guidelines" for **detection** of stress corrosion cracks on the primary side (PWSCC) and secondary side (ODSCC). Conventional refers to a pancake coil with mid-range frequency response around 300 KHz. The following two configurations have been formally qualified per Appendix H:

a. 0.080 inch diameter coil at 200 and 100 KHz

b. 0.080 inch diameter coil at 300 and 200 KHz

"Qualification" requires that a technique demonstrate, at a minimum, a probability of detection (POD) of 0.80 at a 0.90 confidence level for flaws $\geq$ 60%

thru-wall depth on a suitable specimen set as defined by Table S2-2 of Appendix H. The actual field performance for qualified techniques is expected to exceed the minimum criteria, which is in fact the case for the use of conventional MRPC for detection of circumferential cracks based on the field data for the pulled tube specimen set shown below where POD is 83% at 90% confidence level.

Identification	Mode	ID/OD	Max. Depth %	Circum-ferential (Met.) Extent	EC Det.
25-58TTS	Circ.	OD	68	50	Y
39-37TTS	Circ.	OD	20	20	N
20-100TTS	Circ.	OD	28	180	N
23-145TTS	Circ.	OD	64	210	Y
25-19TTS	Circ.	OD	100	330	Y
22-52TTS	Circ.	OD	91	280	Y
23-44TTS	Circ.	OD	100	340	Y
14-118TTS	Circ.	OD	71	350	Y
75-34TTS	Circ.	ID	100	360	Y
13-147TTS	Circ.	OD	100	360	Y
36-130TTS	Circ.	OD	100	360	Y
55-63TTS	Circ.	OD	100	360	Y
64-48TTS	Circ.	OD	100	360	Y
79-83TTS	Circ.	OD	71	360	Y
40-47TTS	Circ.	OD	100	360	Y

Note that in the above table, the only two cracks that were not detected are the ones whose maximum depth is less than 30% through wall. This technique has been qualified since 1992, and has completed "peer review" and incorporation in the industry Performance Demonstration Database. It is currently in version 1.08 of the Qualified Data Analyst (QDA) material, issued in 1994. (The peer review process specified in Appendix G of the Guidelines for a technique's inclusion in the Performance Demonstration Database is a formal review/demonstration of the technique by a minimum of 5 industry QDAs.)

Several utilities are now using a 0.115" D pancake coil which, due to its larger diameter, is considered to be equivalent to or better than the 0.080" D coil for detection of OD flaws (though the advantage in detection may be offset by a loss in sensitivity to spatial resolution). The peer review process for qualification of this coil is in process, and is expected to be completed by the end of May 1995.

Summary

In summary, the PWR Steam Generator Examination Guidelines, Revision 3 (11/92), provide the protocol for developing and applying technology appropriate to manage both existing and emerging damage forms, including circumferential cracking. Within this protocol conventional MRPC technology has been formally qualified since 1992 for detection of stress corrosion cracks (irrespective of orientation - axial or circumferential); and field tube-pull data (shown above) indicate that, for circumferentially oriented stress corrosion cracks, the performance exceeds the minimum requirements of Appendix H of the Guidelines. Experience data provided by the utility owners groups and NSSS vendors indicate that this technology and protocol have adequately managed circumferential cracking. This is supported by: (1) the fact that the recent tube leak at Maine Yankee in July 1994 was due to a "missed" indication from a previous inspection; and (2) available tube-pull and in-situ burst testing data that indicate structural limits have not been violated.

Points to Consider in Circumferential Crack Detection and Length Sizing

1 All tube with distorted expansion transition signals should be re-examined with probes qualified for examination of expansion transitions, if not already so tested.

2 Data should be collected on a push to eliminate the drop through effect at the expansion transition. An axial position encoder may also aid in verifying probe translation quality.

3 Note should be taken of the fact that small cracks in the presence of conductive deposits can yield signals with relatively poor phase correlation between base frequencies.

4 Geometry variations may mask ID initiated cracks. The use of oriented coil voltage ratios may be used to differentiate geometry variations from ID cracks.

5 It may, at times, be beneficial to view C-scan data with the cross hatch turned off.

6 As a minimum, unfiltered data should be reviewed in both the X - Y and C-Scan modes.

7 Filtered data may aid in removing geometric and high frequency noise conditions. Filtered data should not be used to disposition indications from the raw unfiltered frequencies to no-detectable-degradation (NDD).

8 When screening RPC data for circumferential flaws, the screen display should be set such that a signal from a 40% circumferential EDM notch can be clearly seen.

9 When measuring the extent of circumferential cracks, the screen display parameters should be set such that a signal from a 40% circumferential EDM notch will occupy 50% of the X-Y screen. This can result in a clipped C-scan signal, but should ensure that small signals will not be reduced in size such that they might be incorrectly measured.

Note: These parameters may be established using artificial flaws other than a 40% circumferential EDM notch provided the ratio of signal amplitudes between the alternative flaw and the 40% circumferential EDM notch has been established.

10 To measure the circumferential extent of the crack , rotate the C-scan to achieve the best view (typically an end view). With the increased span , determine the end points by viewing a return to null condition. This may require using more than one scan line if geometric offsets exist. The total length should be inclusive of the multiple scan lines.

11 Volumetric calls at the top of tubesheet may represent mixed mode cracking. Indications should be investigated to determine that cracking is not present prior to accepting a volumetric call.

12 Consider the use of alternate probes if detection is compromised by local conditions.

13 Qualified confirmation tools to improve confidence in crack length measurement techniques should be developed.