Florida Power
CORPORATION
Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72

November 5, 1999
3F1199-03

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Crystal River Unit 3 - Special Report 99-03: Once Through Steam Generator (OTSG) Notifications Required Prior to MODE 4 and Results of OTSG Tube Inspections that Fall into Category C-3

Dear Sir:

This letter submits Special Report 99-03 to notify the NRC of information pertinent to the inservice inspection of steam generator tubes during the Crystal River Unit 3 (CR-3) Refueling Outage 11 (11R). In accordance with Improved Technical Specification (ITS) 5.7.2.c, Florida Power Corporation (FPC) is providing, prior to ascension into MODE 4, the following information:

1. Number of tubes plugged and repaired;
2. Crack-like indications and assessment of growth for indications in the first span of the "B" steam generator;
3. Results of in-situ pressure testing;
4. Number of tubes and axially oriented TEC (tube end crack-like) indications left in-service, the projected accident leakage attributed to TEC indications left in service, and an assessment of growth for TEC indications.

Special Report 99-03 also provides information concerning results of OTSG tube inspections that were categorized C-3 as required by ITS 5.7.2.d. This portion of the report is a followup to the NRC notification by FPC on October 26, 1999 (Event No. 36296).

Based on the results of a comprehensive eddy current inspection of both OTSGs, three areas were classified as C-3:

- The lower tubesheet (LTS) crevice region Plus-Point inspection of OTSG-A

  An initial Plus-Point inspection sample of the lower tubesheet crevice region of 528 tubes in OTSG-A determined that more than 1% of the tubes inspected were defective (12 of 528). The inspection sample was classified as C-3.

A001

- The upper tube end roll inspection of OTSG-A and OTSG-B

  A 100% Plus-Point inspection of the upper tube end rolls in both steam generators determined that the number of TEC indications present placed both steam generators in Category C-3 for this specific limited area.

- The sleeved tubes inspection of OTSG-B

  A 40% inspection of the preventative sleeves installed in the lane/wedge region of OTSG-B determined that more than 1% of the sleeved tubes inspected were defective (2 of 66 inspected) and the inspection sample was classified as Category C-3.

While the results of the OTSG-B sleeve inspection and the OTSG-A lower tubesheet kidney region sample inspections were classified as Category C-3, when considered as small independent sample examinations, the overall number of degraded and defective tubes identified is not significant. The total number of defective tubes identified in all examinations combined, excluding the upper tube end roll specific limited area inspections, was less than 1% of the total number of tubes inspected during 11R. Therefore, when the sleeved tube indications in OTSG-B and the LTS kidney region indications in OTSG-A are categorized with the balance of steam generator inspections, the overall classification for the CR-3 steam generators is C-2.

With completion of required 11R repairs, the total number of tubes plugged in OTSG-A is 203 of the 15,531 tubes (1.3%). The total number of tubes plugged in OTSG-B is 703 of the 15,531 tubes (4.5%).

This letter establishes no new regulatory commitments. If you have any questions regarding this submittal, please contact Mr. Sid Powell, Manager, Nuclear Licensing at (352) 563-4883.

Sincerely,

Daniel L. Roderick

D. L. Roderick
Director, Nuclear Engineering & Projects

DLR/gko

Attachment – Special Report 99-03: Once Through Steam Generator Notifications Required prior to MODE 4 and Results of OTSG Tube Inspections that Fall into Category C-3

xc: Regional Administrator, Region II
NRR Project Manager
Senior Resident Inspector

ATTACHMENT

SPECIAL REPORT 99-03

ONCE THROUGH STEAM GENERATOR NOTIFICATIONS REQUIRED PRIOR TO MODE 4 AND RESULTS OF OTSG TUBE INSPECTIONS THAT FALL INTO CATEGORY C-3

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ITS 5.7.2.c REPORT

Inservice inspections of the Crystal River Unit 3 (CR-3) Once Through Steam Generators (OTSGs) were performed during Refueling Outage 11 (11R). In accordance with Improved Technical Specifications (ITS) Section 5.7, Reporting Requirements, Florida Power Corporation (FPC) is submitting Special Report 99-03, for notifications required prior to ascension into Mode 4.

ITS 5.7.2.c states,

> *Following each inservice inspection of the steam generator (OTSG) tubes, the NRC shall be notified of the following prior to ascension into MODE 4:*
>
> 1. *Number of tubes plugged and repaired;*
> 2. *Crack-like indications and assessment of growth for indications in the first span;*
> 3. *Results of in-situ pressure testing, if performed; and*
> 4. *Number of tubes and axially oriented TEC [tube end crack-like] indications left in-service, the projected accident leakage, and an assessment of growth for TEC indications.*

The required information follows:

1. *Number of tubes plugged and repaired (ITS 5.7.2.c.1)*

OTSG	NUMBER OF TUBES		
	PLUGGED	RE-ROLLED	SLEEVED
A	52 (Note 1)	638	0
B	69 (Note 2)	909	0

Note 1: Includes one (1) tube that was plugged due to excessive wall thinning as a result of the repair roll.

Note 2: Includes seven (7) tubes that were plugged due to excessive wall thinning as a result of the repair roll.

2. *Crack-like indications and assessment of growth for indications in the first span (ITS 5.7.2.c.2)*

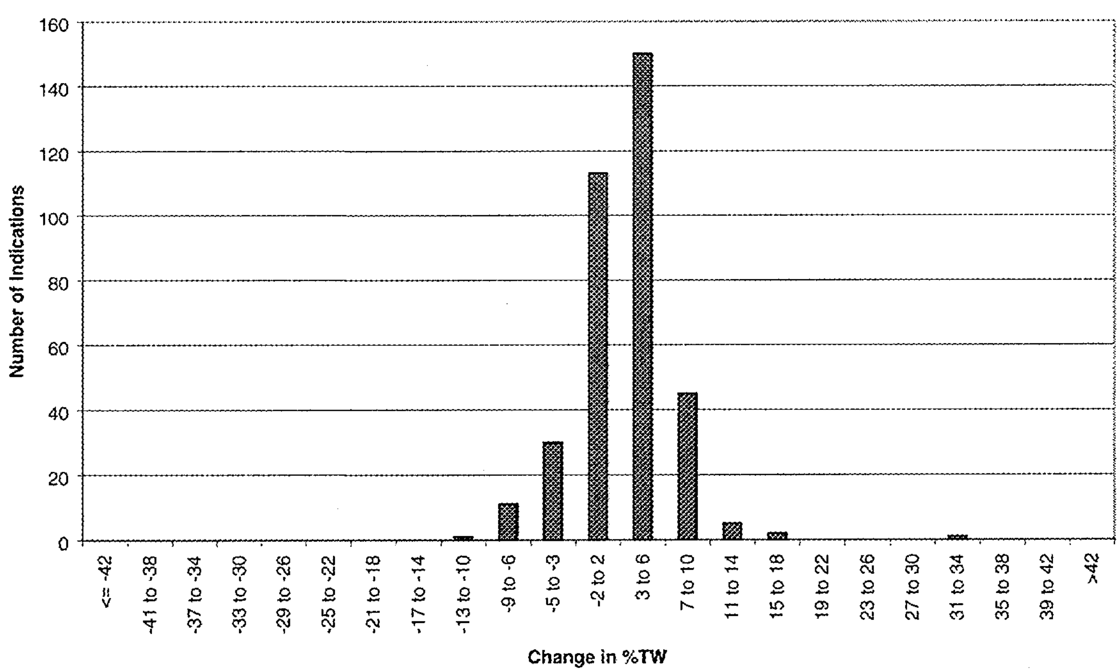
The "first span" is defined as those lengths of tubing which span the region from the secondary face of the lower tubesheet to the first support plate. The number of crack-like indications in the first span identified during this examination follows:

OTSG	NUMBER OF INDICATIONS
A	0
B	0

In 1999, CR-3 examined apparent growth of the first span pit-like intergranular attack (IGA) indications in OTSG-B. The regression technique indicated percent through-wall (TW) for 1999 was compared to the regression technique indicated percent TW from the 1997 inspection. All regression data was obtained using a high frequency bobbin probe. Figure 1 below provides a graphical presentation of this comparison.

The growth of first span pit-like IGA in OTSG-B continues to be essentially zero with the majority of indications exhibiting a - 2% to + 6% change in indicated percent TW. The slightly positive increase in indicated percent through-wall is within the accuracy of the measurement technique used to establish the percent TW depth of the indications.

Figure 1: 1999 to 1997 IGA Percent Through-wall



Nine (9) first span IGA tubes were plugged in OTSG-B due to an assigned percent through-wall of $\geq$ 40%. Eight (8) first span IGA tubes, which had percent through-wall penetrations of <40%, were conservatively plugged in OTSG-B due to an estimated increase in growth of greater than 10% since the last inspection. Twenty (20) first span IGA tubes were plugged due to a lack of historical data for the indications and four (4) tubes were conservatively plugged due to the presence of multiple IGA indications. A total of 157 tubes containing first span IGA indications remain in service in OTSG-B.

The ITS 5.7.2.c.2 requirement to submit an assessment of growth for indications in the first span was originally incorporated as part of a License Amendment that addressed inspection and monitoring requirements for pit-like IGA in the first span of OTSG-B. Therefore, no assessment of growth is being provided for OTSG-A.

3. *Results of in-situ pressure testing (ITS 5.7.2.c.3)*

In-situ pressure testing was performed on four (4) tubes in OTSG-A. No leakage was observed during the tests.

The following table contains information regarding the tubes that were subjected to a full-length pressure test:

OTSG	ROW	TUBE	FLAW TYPE	TEST PRESSURE	DEPTH (%TW)	LENGTH (inches)	ARC (inches)
A	96	1	SAI	4250 psig	97	0.50	N/A
A	111	54	SCI	4700 psig (see Note)	37	N/A	1.86
A	104	52	SCI	4700 psig (see Note)	40	N/A	0.45
A	103	49	SCI	4700 psig (see Note)	55	N/A	0.57

SAI ≡ Single Axial Indication
SCI ≡ Single Circumferential Indication

Note: Test pressure included an upward pressure adjustment to simulate a bounding Steam Line Break (SLB) axial load of at least 604 lb for tubes located in the kidney region.

4. *Number of tubes and axially oriented TEC indications left in-service, the projected accident leakage, and an assessment of growth for TEC indications (ITS 5.7.2.c.4)*

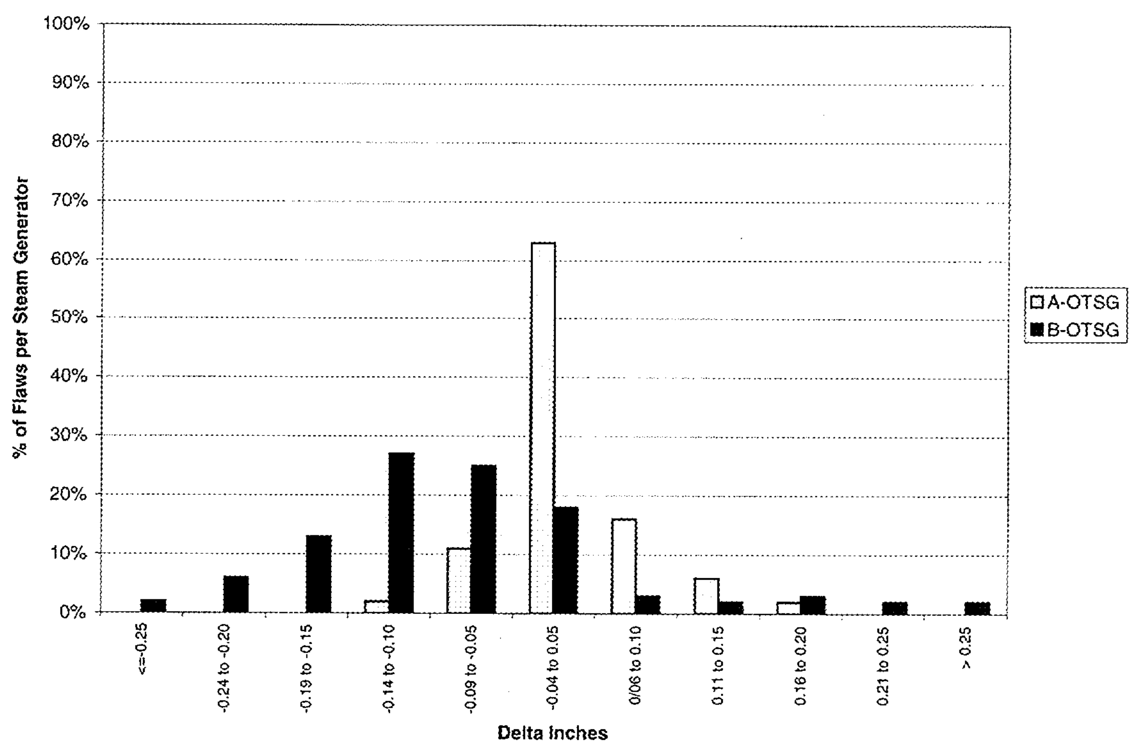
OTSG	TUBES LEFT IN-SERVICE	INDICATIONS
A	435	622
B	437	549

OTSG	PROJECTED ACCIDENT LEAKAGE		
	Leakage Contribution at Room Temperature from Inservice TEC Assuming 100% Through-wall	**Leakage Contribution at Room Temperature from Undetected 100% Through-wall Indications Based on POD of 0.84**	**TOTAL AT ACCIDENT CONDITIONS**
A	0.25 gpm	0.40 gpm	0.78 gpm
B	0.40 gpm	0.33 gpm	0.88 gpm

POD ≡ Probability of Detection

An assessment of growth for TEC indications observed in 1997 was performed to confirm that the indicated location of the flaw tip relative to the clad/carbon steel interface (CCI) had not shown any significant growth towards the interface. Figure 2 below provides a graphical representation of this growth assessment comparing the 1997 flaw tip location to the 1999 flaw tip location. The change in indicated location from the tip of the flaw to the CCI is normally distributed around zero change in location. Therefore, it is concluded that the growth rate of the indications toward the CCI is insignificant.

Figure 2: 1999 Flaw Tip Growth



ITS 5.7.2.d REPORT

The 11R Steam Generator inspection was a comprehensive inspection of all the tubing in both steam generators. The inspections were performed with equipment and techniques qualified in accordance with Appendix H of the Electric Power Research Institute (EPRI) PWR Steam Generator Examination Guidelines, Rev. 5, or demonstrated equivalent. The final inspection scope included:

- 100% Bobbin inspection of all inservice tubes in both OTSGs;
- 100% Plus-Point inspection of all upper tube end rolls in both OTSGs;
- 100% Plus-Point inspection of the lower tubesheet (LTS) crevice in the kidney region of OTSG-A, including a 20% sample of a three (3) tube buffer zone surrounding the kidney region;
- 40% Plus-Point inspection of the LTS crevice in the kidney region of OTSG-B;
- 100% Plus-Point inspection of all inservice sleeved tubes in OTSG-B;
- 20% Plus-Point inspection of all inservice sleeved tubes in OTSG-A;
- 100% Plus-Point inspection of a one (1) tube boundary around the sleeving zone in each OTSG;
- 20% Plus-Point random sample inspection of the 15th tube support plate and upper tubesheet (UTS) secondary face of tubes in the lane/wedge region adjacent to the sleeving zone in each OTSG;
- 100% Plus-Point inspection of inservice Inconel-600 plugs;
- 20% Plus-Point random sample inspection of inservice Inconel-690 plugs;
- 100% Plus-Point inspection of non-stress relieved original rolls in both OTSGs; and
- 100% of inservice tubes in OTSG-B with first span IGA.

The results of 11R inspections were classified in accordance with the defined Categories C-1, C-2, and C-3 of ITS 5.6.2.10.2. The upper tube end roll inspections in each OTSG were inspected as specific limited areas in accordance with ITS Table 5.6.2-3 and were determined to be Category C-3. The results of sleeved tube inspections and the LTS crevice Plus-Point inspections were conservatively classified as separate, critical area inspections. The classification for the OTSG-B sleeved tube inspection was determined to be Category C-3. The classification for the OTSG-A LTS crevice Plus-Point inspection was also determined to be Category C-3.

While the results of the OTSG-B sleeve inspection and OTSG-A LTS crevice region Plus-Point inspection were classified as Category C-3, when considered as small independent sample examinations, the overall number of degraded and defective tubes identified in these areas was not significant. When the sleeved tube indications in OTSG-B and the LTS crevice region indications in OTSG-A were combined with the balance of steam generator inspections included in the periodic random sample for each OTSG, the overall classification for each OTSG was determined to be Category C-2.

Improved Technical Specification 5.7.2.d requires the results of OTSG tube inspections that fall into Category C-3 to be reported to the NRC in accordance with 10CFR50.72. FPC reported the classification of the OTSG-A LTS crevice region, the OTSG-B sleeved tube inspection, and the OTSG-A and OTSG-B upper tube end inspections as Category C-3 inspections on October 26, 1999 (Reference Event No. 36296). The notification included a clarification that while the C-3 report was required by ITS 5.7.2.d, the condition itself did not meet any reporting criterion in 10CFR50.72. The Condition Monitoring Assessment clarified that the structural and leakage integrity limits for the steam generators in the aggregate were not exceeded during the previous cycle.

The following information is provided to more fully characterize the inspection results for each area classified as C-3 during the 11R inspection and reported in Event No. 36296.

OTSG-A LTS Crevice Region Inspection

Eleven (11) circumferentially oriented indications were identified in the OTSG-A lower tubesheet crevice region during an initial Plus-Point inspection sample of 528 tubes. The indications were all located approximately 0.5 inch or less below the LTS secondary face and were adjacent to dent indications. One (1) small volumetric indication was identified just above the LTS secondary face.

Review of the OTSG-A lower tubesheet crevice region eddy current indications by Qualified Data Analysts certified to Eddy Current Level III qualifications determined that the circumferentially oriented indications were most likely indicative of very shallow outside diameter intergranular attack/stress corrosion cracking (ODIGA/SCC) oriented in a tight circumferential band. The exact cause of the indications cannot be determined at this time since no sample indication was removed from the steam generator for chemical or destructive analysis. However, previous tube pulls at CR-3 and other Babcock and Wilcox (B&W) plants have confirmed the presence of IGA in this region.

The OTSG-A lower tubesheet crevice region Plus-Point examination was expanded to encompass 100% of the population of the tubes located in the critical area defined as the kidney region. This expansion was based on engineering judgement and was designed to encompass the majority of tubes with dents at the LTS secondary face in the region with the oldest deepest sludge pile. The expansion also included a sample inspection of tubes in a three (3) tube buffer zone around the kidney region. An additional 2,667 tubes were inspected in OTSG-A. The planned OTSG-B lower tubesheet crevice region Plus-Point examination scope was also increased from 447 tubes to 894 tubes to determine if any similar indications were present in the OTSG-B kidney region.

A total of 24 circumferentially oriented indications were identified in the OTSG-A kidney region during the expanded sample inspection. All identified indications were located on tubes with LTS secondary face dents. The indications were located adjacent to, but not inside the dent indications. No indications were identified in the OTSG-A kidney region buffer zone or during the OTSG-B sample inspection. All tubes in OTSG-A containing indications in this region were removed from service.

OTSG-A and OTSG-B Upper Tube End Roll Inspections

The indications identified in the upper tube end rolls of both steam generators were characterized as primary water stress corrosion cracking (PWSCC). PWSCC was previously detected in the CR-3 tube ends during the 1997 inspection and is a confirmed mode of degradation for OTSG tubes. The planned upper tube end roll inspection in both steam generators included 100% of the inservice tubes such that no sample expansion was required to fully characterize the extent of condition for the tube end cracks (TECs). An Alternate Repair Criteria (ARC) approved in License Amendment 188 was applied as a basis for leaving 435 tubes with TEC in service in OTSG-A and 437 tubes with TEC in service in OTSG-B. The remaining tubes with TEC indications were repaired by re-rolling within the upper tubesheet or were removed from service by plugging.

OTSG-B Sleeved Tube Inspections

Two (2) indications were identified in the pressure boundary portion of the parent tube of sleeved tubes in OTSG-B during a 40% sample inspection. One (1) indication was circumferentially oriented in a location coincident with the sleeve middle roll transition. The second indication was axially oriented in the roll region above the sleeve upper roll. These indications were characteristic of PWSCC-type indications. An expanded sample inspection of 100% of the sleeves in OTSG-B was performed and a 20% sample of sleeved tubes in OTSG-A was added to the inspection scope. One (1) additional axially oriented indication was identified in OTSG-B. The indication was axially oriented in the parent tube roll region coincident with the sleeve upper roll. No indications were identified in OTSG-A. The three (3) sleeved tubes with indications in OTSG-B were removed from service by plugging.

Summary

NRC Information Notice (IN) 97-49, “B&W Once-Through Steam Generator Tube Inspection Findings”, and IN 98-27, “Steam Generator Tube End Cracking”, provided overviews to date of examination findings for B&W steam generators. All of the degradation mechanisms identified during the 11R inspections are characteristic of degradation mechanisms previously identified in B&W steam generators and discussed in NRC Information Notices 97-49 and 98-27.

A Condition Monitoring and Operational Assessment was performed to assess impact of the identified degradation on the structural and leakage integrity of steam generator tubing. The assessment concluded that structural and leakage integrity performance criteria were not exceeded as a result of the C-3 conditions.

A root cause evaluation is being developed as part of the CR-3 Corrective Action Program to investigate what measures can be taken to prevent recurrence of the C-3 classifications.

References

1. Calculation M-99-0088, Revision 0, CR-3 RFO11 TEC ARC Leakage Calculation.

2. In-Situ Pressure Testing Test Plan, Crystal River-3, Fall 1999, Revision 0.

3. E-Mech Technology Report 0726-SR-1, Revision 0, Condition Monitoring and Operational Assessment of Steam Generator Tubing at Crystal River Unit 3, 11R.

4. NRC Information Notice 97-49: B&W Once-Through Steam Generator Tube Inspection Findings, dated July 10, 1997.

5. NRC Information Notice 98-27: Steam Generator Tube End Cracking, dated July 24, 1998.