Florida Power
A Progress Energy Company

Crystal River Nuclear Plant
Docket No. 50-302
Operating License No DPR-72

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

Subject: Crystal River Unit 3 – Response to Request for Additional Information Regarding Fall 2001 Steam Generator Inspection

References:
1. FPC to NRC letter, 3F1001-03, dated October 19, 2001, "Crystal River Unit 3– Special Report 01-01, Once Through Steam Generator (OTSG) Notifications Required Prior to MODE 4"
2. FPC to NRC letter, 3F0102-05, dated January 22, 2002, "Crystal River Unit 3 – Special Report 02-01: Results of the Once Through Steam Generator (OTSG) Tube Inservice Inspection Conducted During Refueling Outage 12" (TAC No. MB3015)

Dear Sir:

The NRC staff requested additional information regarding Florida Power Corporation's (FPC) 2001 inspection of the Once Through Steam Generators. The information was requested through electronic mail and telephone discussions on October 7, 2002 and October 11, 2002.

The Attachment provides FPC's response to the request for additional information (RAI). As part of the response to Question #2, FPC is correcting information previously provided in Reference 2.

This letter establishes no new regulatory commitments.

If you have any questions regarding this submittal, please contact Mr. Sid Powell, Supervisor, Licensing and Regulatory Programs at (352) 563-4883.

Sincerely,

James H. Terry
Engineering Manager

JHT/lvc

Attachment: Response to Request for Additional Information Regarding Fall 2001 Steam Generator Inspection

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

A047

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302/LICENSE NUMBER DPR-72

ATTACHMENT

Response to Request for Additional Information Regarding Fall 2001 Steam Generator Inspection

NRC Request:
Wear at Tube Support Plates (TSPs)

1a. How many wear indications at TSPs are in each steam generator? Are they preferentially located at any particular TSP(s)?

FPC Response:

During the 2001 Refueling Outage 12 (12R), 416 wear indications in 375 tubes were identified in Once Through Steam Generator (OTSG) A and 1,341 indications in 1,155 tubes in OTSG B. The concentrations of wear indications in OTSG A are between the 12th and 7th TSP. The concentrations in OTSG B are between the 10th and 7th TSP. Radial distribution of the wear indications was not preferential.

NRC Request:

1b. When was wear at TSPs first identified at Crystal River 3?

FPC Response:

Outside Diameter (OD) indications (possible wear indications) were first noted as early as the 1st and 2nd inspections. The first tubes to be plugged as a result of in-service degradation were not removed from service until 1987. At that time, three tubes were plugged in OTSG A due to wear.

NRC Request:

1c. What is your basis for concluding that the degradation at the TSPs is wear, versus another volumetric mode of degradation (e.g., outside diameter intergranular attack [OD IGA])?

FPC Response:

Indications identified at a TSP using the bobbin technique are recorded as a non-quantifiable indication (NQI) code, which requires further investigation by rotating coil (RC). RC is performed on NQI to characterize indication. If the indication was determined to be wear by RC and the bobbin signature has not changed, then an additional RC is not necessarily performed. Indications identified with the bobbin coil are analyzed using a flow chart included in the Crystal River Unit 3 (CR-3) Eddy Current Testing (ET) Data Analysis Guidelines (see Figure 1). A fretting type of wear occurs at TSP intersections from vibration and rubbing of the tube against the TSP. Wear is flow-related and has been identified at tube support plate elevations from the 1st to the 15th TSPs (as mentioned above, preferentially between the 12th and 7th TSP in OTSG A and between the 10th and 7th TSP in OTSG B). RC inspections have shown the morphologies of the indications to be volumetric [wear] and consistent with the degradation observed in the OTSG pulled tubes. The flaw characteristics take on the shape of the contact surface. Wear may be circular or "D" shaped or elongated. Wear may be flat bottomed or tapered axially, and may occur at one or more of the broached TSP contact areas or at drilled hole locations. Wear indications are typically small amplitude signals seen as distortions of the TSP lobe. Wear has been observed and monitored at CR-3. Tube pulls in 1994 verified the presence of wear at the

TSPs. Tapered as well as rounded wear scars were destructively examined. The ET sizing of the wear areas showed good correlation with the destructive exam results for these pulled tubes. The indication flow chart is included in the Examination Technique Specification Sheet (ETSS) #1 (Figure 1) of the CR-3 ET Data Analyst Guidelines.

NRC Request:

1d. Have you sized the TSP degradation with other techniques (e.g., technique for OD IGA) to determine the potential impact on structural integrity/leakage integrity if your assumption of wear is incorrect?

FPC Response:

Indications identified in the TSP using a bobbin probe are reported as NQI, which were re-inspected using RC and analyzed for indication characteristics. RC is the qualified detection and sizing technique for wear as well as other forms of degradation such as intergranular attack (IGA) and Primary Water Stress Corrosion Cracking (PWSCC). For the 2001 inspection, if the bobbin indication was previously inspected using RC and the voltage increase was less than .5 volts, then the indication was not further investigated using RC.

NRC Request:

1e. Do you perform a sample of RC inspections on wear to ensure no other degradation is occurring at the TSPs?

FPC Response:

During 12R, 91 tubes in OTSG A and 435 tubes in OTSG B with wear indications were inspected using RC to evaluate the TSP intersections. Three tubes in OTSG A had degradation other than wear [2 single volumetric indications (SVI), 1 single circumferential indication (SCI)] and 3 tubes in OTSG B had degradation other than wear (3 SVI). All six tubes were removed from service.

NRC Request:

1f. In some cases, the wear appears to be outside the TSP, both above and below the TSP. Be prepared to discuss your thoughts on this.

FPC Response:

The primary reason for the measurement discrepancy is thermal growth of the OTSG during the cycle. The main contact points are at the upper and lower point of the TSP. Wear indications have been confirmed to be tapered above and below the TSP. Additionally, wear indication locations are first reported using the bobbin coil technique to identify the location to re-inspect using RC. The measurement of the location is based on the center of the TSP, as measured using ET. Accuracy of the center point is dependant on the response from the TSP on the low frequency channel and the analyst's determination of the center point. When the indication is re-inspected using RC, a measurement is made using "landmarks" as reference points. Accuracy is dependant on the accuracy of the "landmarks."

NRC Request:
Tube End Cracking (TEC) Alternate Repair Criteria (ARC)

2. *Identify the source of the mis-match in Main Steam Line Break (MSLB) values in your October 19, 2001 and January 22, 2002 letters to the NRC.*

FPC Response:

The leakage value mismatch between the two letters was confirmed to be a typographical error in the January 22, 2002 letter. The correct wording of the sentence is: Projected accident leakage contribution at room temperature (RT) from in-service TEC. The 0.504 gpm number for OTSG A should be changed to 0.564 gpm. The 0.556 gpm for OTSG B is correct as written in Reference 2.

NRC Request:
First Span Intergranular Attack (IGA)

3. *The January 22, 2002 letter to the NRC stated that 29 new tubes contain IGA and that 8 of those tubes were plugged. Discuss the reason for plugging.*

FPC Response:

A total of 29 tubes were identified with IGA in the first span of OTSG B that were not previously recorded. Eight of the 29 tubes were removed from service; seven lacked historical evidence of the indications and one tube could not have the regression technique applied. For the seven tubes, at least one previous inspection was reviewed to determine if historical evidence of the indication existed. However, the indications were not detected in previous inspections. One tube had an indication with a phase angle of 41 degrees and could not be regressed. The regression technique can only be applied provided the phase angle on the 600kHz channel is at least 43 degrees.

NRC Request:
Re-Roll ARC

4a. *High-level discussion of how you calculated the Best Estimate Leakage considering Large Break Loss-of-Coolant Accident (LBLOCA) loads.*

FPC Response:

The calculation was performed by ForeLine Associates for FPC. The LBLOCA axial load of 3,900 lbs was postulated to be sufficient to cause circumferential cracks and volumetric indications to go through-wall. The effective crack length formula was derived from the EPRI Ductile Fracture Handbook. Calculations of crack tearing were performed using actual Non-destructive examination (NDE) measured maximum crack depths. The leak rate was determined based on the circumferential crack length. The total leak rate is then determined based on the number of affected tubes per generator and the leak rate per tube re-roll.

NRC Request:

4b. Calculated MSLB leakage for re-rolls for condition monitoring and operational assessment.

FPC Response:

Response for Condition Monitoring Assessment:

The Condition Monitoring Assessment Report lists the following for upper tubesheet expansion zone degradation:

Leakage Integrity Limiting Steam Generator Leak Rate (gpm @ RT)
Axial = 0.034 gpm
Circumferential = 0.025 gpm
Volumetric = 0.0 gpm

Response for the Operational Assessment:

Axial & Circumferential primary water stress corrorion cracking (PWSCC) in Expansion Regions = 0.026 gpm
Volumetric = 0.0 gpm

NRC Request:

4c. Leakage and structural integrity significance of circumferential cracking in original rolls and re-rolls considering MSLB and LBLOCA loads.

FPC Response:

The bounding leak rates are very conservative since the leakage is based on test samples with a full circumferential sever outboard of the repair roll. The majority of the degradation in the tubesheets is short, axial cracks for which the leakage would be much less under axial loads than for the tested severed tube.

The repair roll is applicable to repairing axial, volumetric, or circumferential indications. Testing was conservatively performed with the assumption that the tube is severed at the heel transition (360 Degrees and 100% through-wall circumferential defect).

The Operational Assessment report using both state of the art detailed evaluations and bounding type operational assessments of all operative degradation mechanisms at Crystal River Unit 3 show that deterministic structural integrity and leakage integrity requirements will be met for the next full cycle of operation for a cycle length of at least 2.0 effective full power years (EFPY).

NRC Request:

4d. Did you monitor the ECT data for the occurrence of denting in between rolls? If so, was any denting identified?

FPC Response:

Denting is monitored in the upper tubesheet (UTS) region using bobbin coil technique. Denting was not detected in the location of the re-rolls in the UTS.

NRC Request:
Plugged Tubes - Appendix 3 of the January 22, 2002 Letter

5a. What are single volumetric indications (SVIs) at TSPs and discuss the reason for plugging. (For example, OTSG A – Row 15, Column 6, Row 61, Column 110 and OTSG B – Row 101, Column 124, Row 149, Column 34)?

FPC Response:

Single or Multiple Volumetric Indications (SVI or MVI) are RC indications that are not crack-like yet have some discernible volume and are deemed non-repairable. For example, an indication in the tube freespan that is dispositioned with axial and circumferential dimensions less than the repair limit. OD IGA, identified as SVI or MVI, has been detected in the upper spans and within the upper tubesheet crevice in OTSGs. This has been attributed to corrosion products transporting up the lane and wedge region into the upper tubesheet crevice. This form of IGA is OD initiated and displays a volumetric morphology with rotating techniques. Pit-like IGA has been confirmed by tube pulls in the first span and lower tubesheet of OTSGs. This form of IGA is OD initiated and displays a volumetric morphology with rotating techniques. The tubes are removed from service on a plug-on-detection (excluding the ARC) basis.

NRC Request:

5b. What are SVIs in freespan, and discuss the reason for plugging?

FPC Response:

IGA has been confirmed in the freespan of OTSGs, typically in the upper elevations. IGA was observed on the general surface (IGA crazing) of tubing in the steam region. At some locations, IGA was observed in grooves (Groove IGA) caused during the process of inserting the tubes past the TSP's during assembly. These indications (SVIs) are characterized as axial with rotating techniques and may display a multiple intermittent response over several inches or more of tubing. The tubes are removed from service on a plug on detection (excluding the ARC) basis.

NRC Request:

5c. What are SVIs in upper tubesheet?

FPC Response:

IGA has been noted at the upper tubesheet secondary face and dented TSP locations in OTSGs. These indications are characterized as circumferential with rotating techniques.

NRC Request:

5d. Discuss the circumferential indication identified near the TSP in OTSG A – Row 32, Column 2.

FPC Response:

This indication is a single circumferential indication at or just below the TSP interface. The circumferential extent is approximately 0.23 inch; the through-wall was not measured since the depth measurement is not qualified in accordance with EPRI Examination Guidelines, Appendix H. This indication was not present in the previous inspections. Therefore, the tube was plugged.

NRC Request:

5e. What is the driving mechanism for the crack (e.g., dent, etc.)?

FPC Response:

The exact "driving" mechanism can only be determined by metallurgical evaluation. A dent was not indicated as the initiating factor in the area of the indication. SCC and wear have been previously identified in the upper portion of the tube bundle.

NRC Request:

5f. Discuss the thought process you used to determine whether an expansion of the ET scope was appropriate.

FPC Response:

The indication was identified as an NQI as a result of the bobbin coil inspection of 100% of the inservice tubes. The intersection was re-evaluated using RC. RC revealed a single circumferential indication at or near the tube support plate. Denting was not identified in the area of the indication. Additionally, 136 tubes in OTSG A and 530 tubes in OTSG B (TSP intersections) were also investigated using RC. No other circumferential indications were identified. Since 100% of the tubes were inspected, no additional sampling was possible.

NRC Request:

5g. Describe the leakage/structural integrity significance of the flaw.

FPC Response:

The Condition Monitoring Report discussed this particular tube indication at the 8th TSP. The report concluded: "It is OD in character and may be related to an undetectable circumferential scratch in the same manner as axial groove IGA. Even if cracking is assumed to be 100% though-wall (TW), the 0.23 inch length for this indication is more than one inch less than the condition monitoring acceptance limit length."

NRC Request:

5h. Is it associated with any other degradation?

FPC Response:

No other form of degradation was noted in this area.

NRC Request:

5i. Discuss the circumferential indications approximately 3.5 inches below the upper tube end.

FPC Response:

Two tubes in OTSG B were identified with multiple circumferential indications, approximately 3.25 inch below the tube end. These tubes were removed from service via plugging. The degradation mechanism is believed to be SCC caused by the re-roll from the previous outage. The indications were identified during the 100% RC inspection of the upper tubesheet.

NRC Request:

5j. Are they associated with a re-roll?

FPC Response:

Both tubes were re-rolled in 1999.

NRC Request:

5k. Discuss condition monitoring and operational assessment leakage predictions considering MSLB loads (i.e., total leakage, subtotaled by degradation mode, allowable leakage in licensing basis)

FPC Response:

Condition Monitoring Assessment:

Degradation Mechanism	Leakage Integrity Limiting S/G Leak Rate (gpm@RT)
UTS Expansion Zone Degradation	Axial = 0.034 Circumferential = 0.025 Volumetric = 0
UTS Crevice Axial ODSCC (1)	0
UTS Crevice Volumetric (1)	0
Upper Bundle Volumetric (8)	0
Upper Bundle Axial ODSCC (18)	0
Circumferential ODSCC at O8S (1)	0
Second Span Volumetric (1)	0
Wear	0
First Span Volumetric In S/G B	0
Tube End ARC	0.56
Leaking Plug Seal Weld	0.0007

Operational Assessment:

Projected leak rates in the limiting OTSG

Upper bundle axial ODSCC/IGA = 0.016 gpm

Circumferential ODSCC at a tube support = 0.0 gpm

Axial ODSCC in the upper tubesheet crevice = 0.0 gpm

Volumetric degradation other than in the first span ARC region = 0.0 gpm

Axial and circumferential PWSCC in expansion regions = 0.026 gpm

Volumetric degradation in expansion regions = 0.0 gpm

Wear at tube support locations = 0.0 gpm

Tube end cracking = 0.6 gpm

Allowable leakage in licensing basis:

Allowable leakage is limited to MSLB accident leakage limit of 1.0 gpm minus operational leakage of 150 gallons per day (corrected to room temperature) [1.00 - 0.144 = 0.856 gpm]. This is further reduced by the repair roll leak rate assuming all tubes in the upper tubesheet have been re-rolled (0.05 gpm). Additionally for OTSG B, the leakage is further reduced to account for a leaking welded plug left in service (6.9E-6 gpm). Therefore:

OTSG A

OTSG Leakage Limit = 0.806 gpm
Undetected Leakage = 0.109 gpm
Repair Roll Leakage = 0.050 gpm

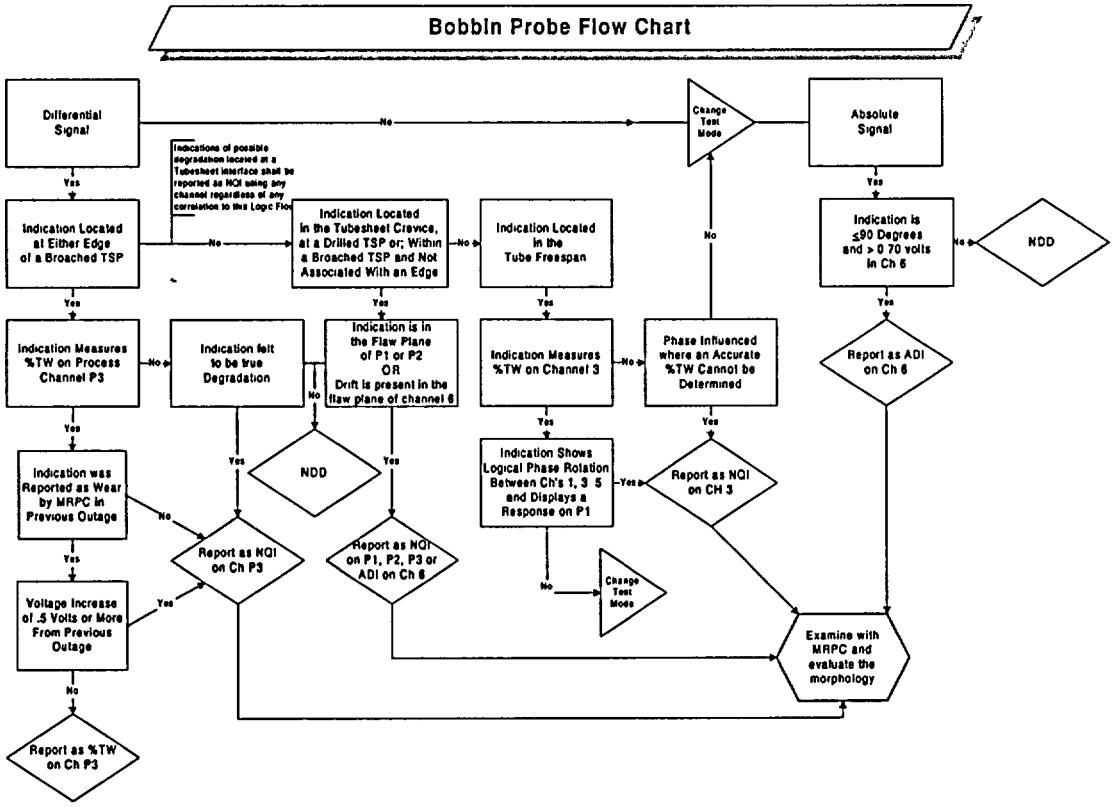
ARC Leakage Limit = 0.647 gpm

OTSG B

OTSG Leakage Limit = 0.806 gpm
Undetected Leakage = 0.154 gpm
Repair Roll Leakage = 0.050 gpm
Weld Plug Leakage = 6.9E-6 gpm

ARC Leakage Limit = 0.601 gpm

Figure 1


Bobbin Probe Flow Chart
Differential Signal
No
Change Test Mode
Absolute Signal
Yes
Indications of possible degradation located at a Tubesheet interface shall be reported as NQI using any channel regardless of any correlation to the Logic Flow
Indication Located at Either Edge of a Broached TSP
No
Indication Located in the Tubesheet Crevice, at a Drilled TSP or; Within a Broached TSP and Not Associated With an Edge
No
Indication Located in the Tube Freespan
No
Indication is ≤90 Degrees and > 0.70 volts in Ch 6
No
NDD
Yes
Indication Measures %TW on Process Channel P3
No
Indication felt to be true Degradation
No
Indication is in the Flaw Plane of P1 or P2 OR Drift is present in the flaw plane of channel 6
Yes
Indication Measures %TW on Channel 3
No
Phase Influenced where an Accurate %TW Cannot be Determined
Yes
Report as ADI on Ch 6
Yes
Indication was Reported as Wear by MRPC in Previous Outage
No
Yes
NDD
Yes
Indication Shows Logical Phase Rotation Between Ch's 1, 3 5 and Displays a Response on P1
Yes
Report as NQI on CH 3
Yes
Report as NQI on Ch P3
Report as NQI on P1, P2, P3 or ADI on Ch 6
No
Change Test Mode
Voltage Increase of .5 Volts or More From Previous Outage
Yes
Examine with MRPC and evaluate the morphology
No
Report as %TW on Ch P3