April 30, 1996

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Mr. Percy M. Beard, Jr.
Senior Vice President,
Nuclear Operations
Florida Power Corporation
ATTN: Manager, Nuclear
Licensing
15760 W. Power Line Street
Crystal River, Florida 34428-6708

Dear Mr. Beard:

SUBJECT: CRYSTAL RIVER NUCLEAR GENERATING PLANT UNIT 3 - ISSUANCE OF AMENDMENT RE: ALTERNATE REPAIR CRITERIA FOR STEAM GENERATOR TUBING (TAC NO. M92548)

Dear Mr. Beard:

The Commission has issued the enclosed Amendment No. 154 to Facility Operating License No. DPR-72 for the Crystal River Unit No. 3 Nuclear Generating Plant (CR-3). The amendment consists of changes to the Technical Specifications (TS) in response to your application dated March 21, 1996, as supplemented April 8, 15, and 18, 1996. The amendment applies only to outside diameter volumetric intergranular attack (IGA) indications located below the first tube support plate and the secondary face of the lower tubesheet (first span) and would allow dispositioning IGA indications within this region based on bobbin coil voltage response and motorized rotating pancake coil (MRPC) probe dimensional measurements. The proposed TS changes are applicable for one cycle only until Refuel 11.

A copy of the Safety Evaluation is enclosed. The Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

Original signed by:
L. Raghavan, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-302
Enclosures:
1. Amendment No. 154 to DPR-72
2. Safety Evaluation
cc w/enclosures:
See next page

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Office	LA: PDII-1	PM: PDII-1	OGC	EMCB	D:PDII-3
Name	EDunnington	LRaghavan	*	JStrosnider	FHebdon
Date	04/25/96	04/29/96	04/26/96	04/24/96	04/29/96
Copy	(Yes)/No	(Yes)/No	Yes/(No)	(Yes)/No	(Yes)

AMENDMENT NO. TO FACILITY OPERATING LICENSE NO. DPR-72

w/o encl.

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

April 30, 1996

Mr. Percy M. Beard, Jr.
Senior Vice President,
Nuclear Operations (SA2A)
Florida Power Corporation
ATTN: Manager, Nuclear
Licensing
15760 W Power Line Street
Crystal River, Florida 34428-6708

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Sincerely,

L. Raghavan, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Amendment No. 154 to DPR-72
2. Safety Evaluation

cc w/enclosures:
See next page

Mr. Percy M. Beard, Jr.
Florida Power Corporation

Crystal River Unit No. 3
Generating Plant

cc:
Mr. Rodney E. Gaddy
Corporate Counsel
Florida Power Corporation
MAC-A5A
P.O. Box 14042
St. Petersburg, Florida 33733

Mr. Bruce J. Hickle, Director
Nuclear Plant Operations (NA2C)
Florida Power Corporation
Crystal River Energy Complex
15760 W. Power Line Street
Crystal River, Florida 34428-6708

Mr. Robert B. Borsum
B&W Nuclear Technologies
1700 Rockville Pike, Suite 525
Rockville, Maryland 20852

Mr. Bill Passetti
Office of Radiation Control
Department of Health and
Rehabilitative Services
1317 Winewood Blvd.
Tallahassee, Florida 32399-0700

Attorney General
Department of Legal Affairs
The Capitol
Tallahassee, Florida 32304

Mr. Joe Myers, Director
Division of Emergency Preparedness
Department of Community Affairs
2740 Centerview Drive
Tallahassee, Florida 32399-2100

Chairman
Board of County Commissioners
Citrus County
110 North Apopka Avenue
Iverness, Florida 34450-4245

Mr. Larry C. Kelley, Director
Nuclear Operations Site Support
(SA2A)
Florida Power Corporation
Crystal River Energy Complex
15760 W. Power Line Street
Crystal River, Florida 34428-6708

Senior Resident Inspector
Crystal River Unit 3
U.S. Nuclear Regulatory Commission
6745 N. Tallahassee Road
Crystal River, Florida 34428

Mr. Gary Boldt
Vice President - Nuclear Production
Florida Power Corporation
Crystal River Energy Complex
15760 W. Power Line Street
Crystal River, Florida 34428-6708

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street N.W., Suite 2900
Atlanta, Georgia 30323

Mr. Kerry Landis
U.S. Nuclear Regulatory Commission
101 Marietta Street, N.W. Suite 2900
Atlanta, Georgia 30323-0199

AMENDMENT NO. 154 TO FACILITY OPERATING LICENSE NO. DPR-72
CRYSTAL RIVER UNIT 3

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

FLORIDA POWER CORPORATION
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CITY OF TALLAHASSEE

DOCKET NO. 50-302

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 154
License No. DPR-72

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Florida Power Corporation, et al. (the licensee) dated March 21, 1996, as supplemented April 8, 15, and 18, 1996, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-72 is hereby amended to read as follows:

   Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 154, are hereby incorporated in the license. Florida Power Corporation shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

Frederick J. Hebdon, Director
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical
Specifications

Date of Issuance: April 30, 1996

ATTACHMENT TO LICENSE AMENDMENT NO. 154

FACILITY OPERATING LICENSE NO. DPR-72

DOCKET NO. 50-302

Replace the following pages of the Appendix "A" Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

Remove	Insert
3.4-22	3.4-22
5.0-14	5.0-14
5.0-16	5.0-16
	5.0-16A
5.0-17	5.0-17
5.0-29	5.0-29
	5.0-29A
B 3.4-55	B 3.4-55

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.12 RCS Operational LEAKAGE

LCO 3.4.12 RCS operational LEAKAGE shall be limited to:

a. No pressure boundary LEAKAGE;

b. 1 gpm unidentified LEAKAGE;

c. 10 gpm identified LEAKAGE; and

d. 150 gpd of primary-to-secondary LEAKAGE through any one steam generator (OTSG).

Two OTSGs shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. RCS LEAKAGE not within limits for reasons other than pressure boundary LEAKAGE.	A.1	Reduce LEAKAGE to within limits.	4 hours
B. Required Action and associated Completion Time not met. OR Pressure boundary LEAKAGE exists.	B.1 AND B.2	Be in MODE 3. Be in MODE 5.	6 hours 36 hours

5.6 Procedures, Programs and Manuals

5.6.2.10 OTSG Tube Surveillance Program (continued)

in the specific area of an OTSG are inspected with the inspection result classification and the corresponding action required as specified in Table 5.6.2-3. No credit will be taken for these tubes in meeting minimum sample size requirements. Degraded or defective tubes found in these areas will not be considered in determining the inspection results category as long as the mode of degradation is unique to that area and not random in nature.

The results of each bobbin coil sample inspection shall be classified into one of the following three categories:

----------NOTE----------
In all inspections, previously degraded tubes whose degradation has not been spanned by a sleeve must exhibit significant increase in the applicable imperfection size measurement (≥ +0.3V bobbin coil amplitude increase for first span IGA indications or >10% further wall penetration for all other imperfections) to be included in the below percentage calculations.

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

(continued)

5.6 Procedures, Programs and Manuals

5.6.2.10 OTSG Tube Surveillance Program (continued)

4. Acceptance criteria:

a. Vocabulary as used in this Specification:

1. Tubing or Tube means that portion of the tube or sleeve which forms the primary system to secondary system pressure boundary.

2. Imperfection means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Any indications below all degraded tube criteria specified in item 4 below may be considered as imperfections.

3. Degradation means a service-induced cracking, wastage, wear, or general corrosion occurring on either inside or outside of a tube.

4. Degraded Tube means a tube containing a first span IGA indication with a bobbin coil amplitude $\geq$ 0.65V or $\geq$ 0.13 inches axial extent or $\geq$ 0.3 inches circumferential extent or imperfections $\geq$ 20% of the nominal wall thickness caused by degradation except where all such degradation has been spanned by the installation of a sleeve.

5. % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

6. Defect means an imperfection of such severity that it exceeds the plugging/sleeving limit except where the imperfection has been spanned by the installation of a sleeve. A tube containing a defect in its pressure boundary is defective. Any tube which does not permit the passage of the eddy-current inspection probe shall be deemed a defective tube.

(continued)

5.6 Procedures, Programs and Manuals

5.6.2.10 OTSG Tube Surveillance Program (continued)

7. First span Inter-granular Attack (IGA) indications mean a bobbin coil indication located between the lower tubesheet secondary face and the first tube support plate confirmed by MRPC to have a volumetric morphology characteristic of IGA.

8. Plugging/Sleeving Limit means the extent of degradation beyond which the tube shall be restored to serviceability by the installation of a sleeve or removed from service because it may become unserviceable prior to the next inspection. The limit for first span IGA indications is a bobbin coil amplitude of 1.25V or an axial extent of 0.25 inches or a circumferential extent of 0.6 inches. The limit for indications other than first span IGA is 40% of the nominal tube or sleeve wall thickness. No more than five thousand sleeves may be installed in each OTSG.

(continued)

5.6 Procedures, Programs and Manuals

9. Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a main steam line or feedwater line break, as specified in 5.6.2.10.3.c, above.

10. Tube Inspection means an inspection of the entire OTSG tube as far as possible.

b. The OTSG shall be determined OPERABLE after completing the corresponding actions (plug or sleeve all tubes exceeding the plugging/sleeving limit and all tubes containing through-wall cracks) required by Table 5.6.2-2 (and Table 5.6.2-3 if the provisions of Specification 5.6.2.10.2.d are utilized). Defective tubes may be repaired in accordance with the B&W process (or method) equivalent to the method described in report BAW-2120P.

5.6.2.11 Secondary Water Chemistry Program

This program provides controls for monitoring secondary water chemistry to inhibit steam generator tube degradation and low pressure turbine disc stress corrosion cracking. The program shall include:

a. Identification of a sampling schedule for the critical variables and control points for these variables;

b. Identification of the procedures used to measure the values of the critical variables;

(continued)

5.7 Reporting Requirements

5.7.2 Special Reports (continued)

The following Special Reports shall be submitted:

a. When a Special Report is required by Condition B or F of LCO 3.3.17, "Post Accident Monitoring (PAM) Instrumentation," a report shall be submitted within the following 14 days. The report shall outline the preplanned alternate method of monitoring, the cause of the inoperability, and the plans and schedule for restoring the instrumentation channels of the Function to OPERABLE status.

b. Any abnormal degradation of the containment structure detected during the tests required by the Containment Tendon Surveillance Program shall be reported to the NRC within 30 days. The report shall include a description of the tendon condition, the condition of the concrete (especially at tendon anchorages), the inspection procedures, the tolerances on cracking, and the corrective action taken.

c. Following each inservice inspection of steam generator (OTSG) tubes, the NRC shall be notified of the following prior to ascension into MODE 4:

1. Number of tubes plugged and sleeved

2 Crack-like indications in the first span

3. An assessment of growth in the first span indications, and

4. Results of in-situ pressure testing, if performed.

The complete results of the OTSG tube inservice inspection shall be submitted to the NRC within 90 days following the completion of the inspection. The report shall include:

1. Number and extent of tubes inspected,

2. Location and percent of wall-thickness penetration for each indication of an imperfection,

3. Location, bobbin coil amplitude, and axial and circumferential extent (if determined) for each first span IGA indication, and

4. Identification of tubes plugged and tubes sleeved.

5.7 Reporting Requirements

5.7.2 Special Reports (continued)

Results of OTSG tube inspections that fall into Category C-3 shall be reported to the NRC prior to resumption of plant operation. This report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

BASES

LCO

c. Identified LEAKAGE (continued)

LEAKAGE and is well within the capability of the RCS makeup system. Identified LEAKAGE includes LEAKAGE to the containment from specifically known and located sources, but does not include pressure boundary LEAKAGE or controlled reactor coolant pump (RCP) seal leakoff (a normal function not considered LEAKAGE). Violation of this LCO could result in continued degradation of a component or system.

d. Primary to Secondary LEAKAGE through All Steam Generators (OTSGs)

This LEAKAGE limit complements the statistical analysis performed as the basis for the disposition strategy for first span Intergranular Attack (IGA) eddy current indications. The statistical analysis demonstrates low probability of LEAKAGE from first span IGA indications during the operating cycle. This reduced LEAKAGE limit is intended to provide additional assurance that if primary to secondary LEAKAGE were to occur, it will be detected, and the plant shut down in a timely manner. Primary to secondary LEAKAGE must be included in the total allowable limit for identified LEAKAGE.

Two OTSGs are also required to be OPERABLE. This requirement is met by satisfying the augmented inservice inspection requirements of the Steam Generator Tube Surveillance Program (Specification 5.6.2.10).

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 154 TO FACILITY OPERATING LICENSE NO. DPR-72

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

DOCKET NO. 50-302

1.0 INTRODUCTION

By letter dated March 21, 1996, the Florida Power Company (the licensee) submitted a request for changing the Crystal River Unit 3 (CR-3) Technical Specifications (TS). The proposed amendment revises the CR-3 TS to permit the use of voltage and dimensional-based steam generator tube repair criteria to disposition tube indications during inspections in the Refuel 10 outage. The tube repair criteria applies only to outside diameter volumetric intergranular attack (IGA) indications located below the first tube support plate and the secondary face of the lower tubesheet (first span). The licensee's proposed TS changes would allow the disposition of volumetric IGA indications within this region of the CR-3 steam generators based on bobbin coil voltage response and motorized rotating pancake coil (MRPC) probe dimensional measurements. The proposed TS changes would be applicable to only first span IGA indications and for one cycle only until Refuel 11.

Previously, by letter dated May 31, 1995, the licensee proposed TS changes which addressed both first span IGA and wear at the steam generator tube support locations. The March 21, 1996 submittal superseded the May 31, 1995, request in its entirety.

The Commission noticed the licensee's March 21, 1996 request for license amendment and proposed no significant hazards consideration determination in the Federal Register on March 28, 1996 (61 FR 13888). The licensee submitted additional information to support its proposed alternate repair criteria in letters dated April 8, 15, and 18, 1996, which did not change the original proposed no significant hazards consideration determination.

The staff has completed its review of the proposed one cycle amendment. The following summarizes the staff's conclusions.

2.0 BACKGROUND

Steam generator tube flaw acceptance criteria (i.e., plugging limits) are specified in the plant TS. The traditional strategy for achieving adequate structural and leakage integrity of the tubes has been to establish a minimum wall thickness requirement in accordance with guidance in NRC Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes."

Development of minimum wall thickness requirements to satisfy RG 1.121 was governed by analyses assuming a uniform thinning of the tube wall. This assumed degradation mode is inherently conservative for all other forms of steam generator tube degradation. Conservative repair limits may lead to the removal of tubes from service with adequate structural and leakage integrity for further operation.

Eddy current inspection data obtained in the CR-3 refueling outages in 1990 and 1992 identified a significant number of indications in the first span. At the time of their detection, the origin and nature of this tube degradation could not be clearly established. Subsequent tube pulls and destructive examinations identified the degradation as pit-like IGA. Based on a review of previous eddy current data, the licensee concluded that the indications were present dating back to a chemistry excursion in the 1980 timeframe. Tube burst testing of first span IGA tube defects demonstrated that the degraded tube samples removed from the CR-3 steam generators had significant margins with respect to criteria in RG 1.121, despite the IGA depths in excess of the 40 percent plugging limit for several of the degraded locations.

The licensee concluded that the existing 40 percent plugging limit in the CR-3 TS was conservative for this form of degradation and conventional bobbin coil sizing techniques could not be used to accurately determine the depth of these indications. Accordingly, by letter dated March 4, 1994, the licensee submitted proposed alternate disposition strategies for these indications. However, this request was subsequently withdrawn by the licensee (licensee letter dated May 5, 1994) due to several unresolved technical issues associated with the proposed permanent repair criteria. The NRC issued a Confirmatory Action Letter (CAL) on April 26, 1994, related to the licensee's proposed criteria to disposition low signal-to-noise (e.g., first span IGA) indications in the CR-3 steam generators. The CAL required the licensee to submit a permanent TS amendment based on the results of the pulled tube data to address the pit-like IGA flaws no later than May 31, 1995.

Accordingly, by letter dated May 31, 1995, the licensee proposed TS changes which involved broad and long-term criteria addressing volumetric IGA degradation located throughout the CR-3 steam generators and mechanical wear at the tube support plate locations. By letter dated March 21, 1996, the licensee superseded its May 31, 1995 request and proposed more limited TS changes that would apply only to volumetric IGA indications located below the first tube support plate and above the lower tubesheet secondary face. The proposed amendment would be valid until Refuel 11.

3.0 PROPOSED TUBE REPAIR CRITERIA

Crystal River Nuclear Plant, Unit 3, TS 3.4.12, 5.6.2.10, and 5.7.2 are revised by this amendment request to specify voltage/dimensional-based tube repair criteria for volumetric eddy current indications located below the first tube support plate and above the secondary face of the lower tubesheet. The changes in the TS for the one-cycle implementation of the proposed repair criteria include, in part:

a. Decreasing the reactor coolant system primary to secondary operational leakage limits from 1 gallon per minute (1440 gallons per day (gpd)) through all steam generators to 150 gpd through any one steam generator.

b. Specifying that an increase in the imperfection size measurement for volumetric indications in the first span of the CR-3 steam generators are those indications exhibiting an increase in the bobbin coil signal amplitude equal to or greater than 0.3 volts.

c. The definition of a degraded tube is modified to address those tubes containing first span IGA indications. Tubes containing such indications are considered degraded if the bobbin coil amplitude is $\geq$ 0.65 volts or if the dimensions of the indication are greater than or equal to 0.13 inches axial or 0.3 inches circumferential.

d. First span IGA indications are defined as those indications as detected with a bobbin coil probe located between the lower tubesheet secondary face and the first tube support plate confirmed by a MRPC probe to have a volumetric morphology characteristic of IGA.

e. The plugging/sleeving limit is revised to incorporate the one-cycle alternate repair limits for first span IGA indications. The limits for these indications beyond which a tube shall be restored to serviceability by the installation of a sleeve or removed from service are as follows:

   1. Bobbin coil voltage amplitude $\geq$ 1.25 volts

   2. Axial dimensional extent $\geq$ 0.25 inches

   3. Circumferential dimensional extent $\geq$ 0.6 inches

f. The following reporting requirements are proposed for this amendment:

   Following inservice inspection of steam generator tubes, the NRC shall be notified of the following prior to ascension into Mode 4:

   1. Number of tubes plugged and sleeved,

   2. Crack-like indications in the first span,

   3. An assessment of growth in the first span indications, and

   4. Results of in-situ pressure testing, if performed.

   The licensee is required to submit to the NRC within 90 days following the completion of the inspection the results of the steam generator tube inservice inspection. The report will also include the location, bobbin coil amplitude, and axial and circumferential extent (if determined) for each first span IGA indication.

In addition to the proposed TS changes above, the licensee committed to perform in-situ pressure testing of a number of tube indications in the Refuel

10 outage to provide additional assurance of leakage integrity for tubes left in service as a result of the amendment.

4.0 EVALUATION

The proposed alternate disposition strategy for the first span indications relies on bobbin coil voltage, MRPC probe dimensional (i.e., length and width) measurements, and supplemental in-situ pressure testing to assure that tubes left in service as a result of applying the repair criteria have adequate structural and leakage integrity for continued service through the end of the operating cycle following Refuel 10. The magnitude of the bobbin coil probe voltage is sensitive to the overall size of volumetric indications. This has been successfully demonstrated in the sizing of other volumetric tube damage caused by mechanical wear at the tube support plate intersections. The bobbin coil probe would be used as the primary method for detecting and monitoring potential growth of tube indications. Since the amplitude of the voltage response from this probe should vary according to the size of a volumetric indication, the licensee has proposed to remove from service those tubes containing indications that exceed a bobbin coil voltage limit.

All first span indications detected with the bobbin probe that have not been inspected with an MRPC probe will undergo an initial MRPC probe examination to confirm the degradation mode of the indication (e.g., volumetric). The MRPC probe will also be used to measure the length and width of indications per the proposed repair criteria. If these dimensional measurements and the bobbin coil voltage are within the proposed limits then the degradation in the tube is considered acceptable for continued service. The licensee has proposed a bobbin coil repair limit of 1.25 volts. Tubes with indications exceeding the 1.25 volt limit shall be removed from service regardless of the dimensional measurements from the MRPC data. Tube structural integrity in accident conditions is assured via the proposed dimensional limits (see Section 4.3). Indications with axial lengths less than or equal to 0.25 inches or circumferential lengths no greater than 0.6 inches are considered to have adequate margins to preclude burst under design basis tube differential pressure loading.

4.1 Inspection Issues

The proposed tube repair criteria require the use of both bobbin and MRPC inspection probes. MRPC probes are used to size and characterize the nature of degradation detected by the bobbin probe. All first span indications detected with the bobbin coil probe that have not been inspected with an MRPC probe during a prior inspection will be inspected with a rotating probe. One purpose of the MRPC inspection is to characterize the nature of the degradation mode as either crack-like or volumetric. Any crack-like indications are to be dispositioned according to the 40 percent depth repair criteria. The licensee has proposed to incorporate into the TS for this one-cycle amendment, a requirement to submit a list of all crack-like indications identified in the first span of the CR-3 steam generators during the Refuel 10 inspections. To date no axial tube cracking has been identified in either of the steam generators.

As stated above, the MRPC probes will be used to verify that the first span indications are volumetric degradation. These probes can provide the data necessary to determine whether the mode of degradation is either crack-like or volumetric. Nevertheless, the bases for the licensee's proposed repair criteria do not rely on the assumption of volumetric tube degradation. Leakage and structural margins (Sections 4.3 and 4.4) assume a limiting flaw geometry (i.e., crack-like or volumetric) for the proposed one cycle amendment.

The dimensional limits of inservice volumetric indications are determined by inspections with MRPC probes. The licensee has assessed the dimensional measurement capability of these probes as follows. Using the MRPC data from inspections of pulled tube sections, analysts assigned length and width measurements to indications detectable with MRPC probes. The resulting dimensions were compared with the measurements obtained during the destructive examination of the tube sections. The licensee concluded that measurements based on MRPC probe data will overestimate the actual flaw dimension. This would theoretically allow for an increase in the proposed dimensional repair limits; however, the licensee has elected to establish the repair limits at the calculated tube structural limits with no allowance for NDE uncertainty.

Eddy current indications dispositioned using the bobbin coil data are sized using the peak-to-peak voltage response. Those indications with prior MRPC history, acceptable dimensional limits, and voltages less than or equal to the proposed repair limit of 1.25 volts are considered acceptable for continued service. If an indication is detected that has not been inspected with an MRPC probe, the licensee is required to perform such an inspection to characterize the degradation mode and size the dimensions of the indication. The proposed 1.25 volt limit is based on a qualitative assessment of bobbin coil voltages for the population of tube indications and pulled tube destructive examination results.

Metallographic examinations of CR-3 pulled tubes revealed that the pit-like IGA defects often appeared in close proximity to one another on the tubes. Because the bobbin coil probe is sensitive to indications located around the entire tube circumference some of the signals detected with the bobbin coil probe inspections may be due to the presence of multiple pit-like IGA defects. The voltage response from multiple defects will be greater than or equal to that from any of the individual defects. Thus, the bobbin coil voltage repair limits should be conservative for closely spaced defects.

Based on the results of several growth studies, the licensee has concluded that the degradation mechanism for the IGA defects in the first span is dormant (see Section 4.2). However, the licensee has proposed to reinspect with an MRPC probe any indication where the bobbin coil probe voltage response increases by 0.3 volts from the previous inspection. The purpose of the reinspection is to assess an indication's continued acceptability for service. Tubes with indications exhibiting a voltage growth of at least 0.3 volts will be considered degraded and will be included in the classification of the inspection results (i.e., C-1, C-2, or C-3) per TS 5.6.2.10.

Several of these growth studies also noted that there was a fair degree of scatter in the voltages measured between subsequent outages. The proposed

voltage growth threshold of 0.3 volts was determined through a review of the outage-to-outage scatter in bobbin coil voltages for a large number of indications. The voltage change between inspections for a majority of the indications varied within ±0.3 volts. The proposed 0.3 volt "growth trigger" for MRPC reinspection is derived based upon technical judgement and is intended to provide, with some assurance, that should actual degradation growth occur between the inspections for certain indications, those indications will be identified by a voltage change above an appropriate threshold. Further evaluation of the growth of the first span IGA defects is given in Section 4.2 of this Safety Evaluation.

The NRC staff concludes that the proposed inspection methodology to detect, characterize, size, and assess the growth of tube indications located below the first tube support plate and above the lower tubesheet secondary face is an acceptable means to manage the volumetric IGA degradation evident in the first span of the CR-3 steam generators for the next cycle of operation. The staff notes that it would be necessary to address the following inspection-related issues if the licensee requests to pursue a more permanent repair criteria for use during and beyond the Refuel 11 outage: (1) commit to a consistent inspection method (i.e., acquisition techniques, data analysis guidelines, etc.) to ensure outage-to-outage voltage repeatability; (2) complete a detailed assessment of non-destructive examination (NDE) uncertainty including acquisition uncertainty, probe wear, and analyst variability; (3) relate a voltage growth threshold for MRPC inspection to the level of NDE uncertainty; (4) expand the inspection scope to examine all known first span volumetric indications at each inspection; and (5) conduct routine supplemental MRPC probe inspections to complete dimensional growth rate studies and to assess that the morphology of the indications continues to be pit-like.

4.2 Growth Assessment of First Span IGA Indications

Up through the 1992 inspections, the licensee had dispositioned first span indications in the CR-3 steam generators as low signal-to-noise indications in accordance with their inspection procedures. Tube sections removed during the 1992 refueling outage identified the low amplitude bobbin signals as volumetric IGA. Since the indications were confirmed as IGA, the licensee has sponsored several studies to assess the growth of the first span indications. These studies primarily relied upon a review of eddy current data from previous inspections.

The bobbin coil voltage response to similar volumetric defects varies with overall size of an indication. Bobbin coil voltage response should increase as a defect becomes larger or, in the case of IGA, as a loss of material and a weakening of the grain boundaries occur. Thus, an increase in the bobbin voltage amplitude between successive inspections may be an indication that some growth occurred. Prior to the Refuel 10 outage, three separate studies were completed to evaluate the growth of the first span IGA indications in the CR-3 steam generators. B&W Nuclear Services (BWNS) completed an investigation of the growth rate for both the first span and tube support plate indications in the CR-3 steam generators. The study examined eddy current inspection data obtained during the 1989, 1990, and 1992 inspections. The study compared the change in measured voltage between inspections for a number of indications

detected with the bobbin coil probe. The results from the growth study of the first span indications led BWNS to conclude that the first span indications do not show evidence of growth. However, because of the scatter in the data, it was recommended that an allowance be included in the repair criteria for potential growth.

The Electric Power Research Institute (EPRI) also completed a study to assess whether the initiation and growth of the IGA degradation in the CR-3 steam generators was a one-time phenomenon or an ongoing process. EPRI reviewed eddy current data from tubes inspected in the 1989, 1990 and 1992 inspections. Based on the change in the phase rotation of the bobbin coil lissajous signal and the voltage amplitude for the indications evaluated, the study concluded that there was no evidence of IGA growth.

Following the 1994 inspections, Packer Engineering completed a growth study for freespan indications in the CR-3 steam generators. Approximately 300 freespan indications from both steam generators were included in the study. Voltages were compared for indications detected in both the 1992 and 1994 inspections. The study concluded that there was no growth of these indications between the two outages.

The licensee's submittal to the NRC dated March 21, 1996, contains the results of a growth rate evaluation of first span IGA indications in the CR-3 steam generators. The study compared the bobbin coil voltage amplitudes obtained during the 1994 and 1996 inspections for all tubes inspected in both outages. No significant changes in voltage, phase angle or noise component of the signal were noted. On this basis, the licensee concluded that there was no growth of the first span IGA indications during Cycle 10.

Although four separate analyses to assess the potential growth of the IGA indications in the CR-3 steam generators concluded that there was no apparent growth, the NRC staff has identified a number of variables not specifically addressed in these studies. These variables could affect the bobbin voltage response and inhibit the ability to detect a voltage increase for some of the indications caused by actual growth. Such effects would make an accurate assessment of limited growth difficult. The sources of variability identified by the NRC staff include: (1) bobbin probe wear, (2) calibration practices and standards, (3) differences in data acquisition hardware, and (4) data analyst uncertainty. As stated in the licensee's submittal dated December 5, 1995, the data from the 1989, 1990, and 1992 inspections were obtained with probes of different diameters and varying lengths and types of extension cable; the analyst guidelines differed slightly between inspections; the calibration standards used in the three inspections were different; and probe wear effects were not considered within any of the studies. Although the above factors were not assessed in the separate studies, the licensee concluded that the IGA degradation mechanism is currently not active.

In order to address the issues of probe wear and analyst variability and their effects on the potential voltage variability, the licensee inspected a sample of tubes twice during the Refuel 10 outage. The second inspections were completed using the same acquisition technique with the exception that a new bobbin probe was used. A new bobbin probe was used to eliminate probe wear as a potential source of error in the reinspection. Based on an analysis of the

data obtained from each of the inspections completed in the Refuel 10 outage, the licensee calculated the combined voltage uncertainty effects from analyst variability and probe wear to be 14.3 percent.

Since the bobbin coil voltage amplitude is sensitive to the size of volumetric indications, the bobbin probe data should be an effective screening tool for the detection of growth for the first span IGA indications at CR-3. However, as noted in several of the growth studies, the outage-to-outage variation in voltage for these indications may vary significantly between successive inspections. The NRC staff believes these variations may be caused by one or more of the sources of error discussed previously. Such variations make it difficult to accurately assess growth. However, none of the growth analyses revealed a well-defined increase in the mean voltage for the population of indications studied. This indicates that the growth of the IGA defects is below the level of scatter in the voltage measurements due to NDE uncertainty. In the absence of a definitive assessment of NDE uncertainty, the NRC staff concludes that the population of IGA indications may be experiencing limited growth during operation. However, since the potential growth for the next cycle would be expected to proceed at a rate similar to prior operational cycles, the staff concludes that tubes left in-service as a result of using the proposed repair criteria should maintain similar structural and leakage integrity margins through the end of the next operating cycle.

4.3 Structural Integrity Assessment

The proposed tube repair criteria includes dimensional as well as voltage-based limits. The dimensional limits are imposed to prevent tube burst during both normal operation and accident loading conditions. The repair criteria limits the axial and circumferential length of volumetric degradation. The axial extent of tube degradation is limited to 0.25 inches. The circumferential lengths of all volumetric indications must not exceed 0.60 inches. Tubes with indications that have measured dimensions in excess of either the axial or circumferential dimensional limits are considered defective and must be removed from service per the TS.

The licensee submitted the results of an analysis [Reference x] completed in accordance with the guidance provided in RG 1.121 which determined the maximum allowable dimensional limits for in-service tube degradation. The proposed axial flaw limit of 0.25 inches utilizes the results from the NRC-sponsored Steam Generator Tube Integrity Program [Reference: NUREG-0718, "Steam Generator Tube Integrity Program - Phase I Report," September 1979]. A correlation relating flaw length, flaw depth and burst pressure was developed by the NRC through testing of axially notched specimens. Using these results the licensee concluded that a degraded steam generator tube with a 0.25 inch long, 87 percent through-wall depth axial flaw could sustain design basis differential pressure loads without burst. The proposed indication circumferential limit was determined assuming a 100 percent through-wall flaw extending partially around the tube. A limit load evaluation of the imposed axial tube loads during design basis conditions concluded that the tube would not structurally fail with a through-wall flaw extending 0.60-inches around the tube circumference.

To further assess the first span eddy current indications in the CR-3 steam generators, the licensee removed tube sections in the 1992 and 1994 refueling outages. Four tube sections containing first span indications underwent burst pressure testing. Subsequent metallographic analyses identified many volumetric indications in the tube sections subject to the tests. Three of the four tubes burst at a volumetric IGA degradation previously located between the lower tubesheet secondary face and the first tube support plate. Two of the three tube sections which failed due to first span IGA degradation failed at locations with defect depths measured at 54 percent through-wall. Despite a defect depth of penetration greater than one-half the tube wall thickness for these tube indications, the burst pressures were approximately equal to that for an undegraded tube section. One of the four tube sections failed during burst testing at degradation previously located within the tubesheet crevice. The burst pressure for that defect was approximately 35 percent less than that for the undegraded tube. However, the burst pressure was well in excess of the margins specified in RG 1.121. In addition, the degradation was located outside the region of the steam generator for which the proposed amendment applies.

The proposed dimensional limits are based on a RG 1.121 assessment assuming linear (i.e., crack-like) flaw geometries. MRPC probe inspection results of first span IGA indications have characterized the indications as volumetric rather than crack-like. This conclusion has been verified through destructive examinations of pulled tube sections. Tests of pulled tube sections have demonstrated that the burst pressures for tubes containing this form of tube degradation were comparable to those for the undegraded tubing. The licensee has completed analytical calculations providing the basis for the proposed dimensional limits that assume a linear (i.e., crack-like) flaw geometry. This should result in conservative dimensional repair limits with respect to the actual volumetric nature of the IGA degradation. The licensee has demonstrated the ability to adequately assess the dimensional extent of tube degradation through measurements with MRPC probes. For the reasons stated above, the NRC staff concludes that the proposed dimensional repair limits are acceptable for this cycle-specific amendment.

4.4 Leakage Integrity Assessment

In order to maintain leakage integrity during accident conditions, the licensee has concluded that the through-wall depth of degradation left in service using the proposed repair criteria should be less than 87 percent. The licensee initially proposed using a correlation relating bobbin coil voltage to defect volume and another correlation relating defect volume to depth to assure that tubes left in service under the proposed repair criteria would have adequate leakage integrity under main steam line break (MSLB) differential pressure loading. Using the voltage-volume and volume-depth correlations, the licensee attempted to demonstrate that indications with bobbin voltages less than 1.5 volts will have a through-wall depth less than 87 percent. Due to the scatter in the individual correlations, the licensee could not establish a statistically-based voltage limit. Attempts to develop such a limit produced results that were inconsistent with the pulled tube data.

The metallographic examinations of tube sections removed during the 1992 and 1994 refueling outages identified a number of IGA defects. The first span degradation ranged up to 62 percent through-wall. Thus, the deepest first span indications identified from the tube pulls had a remaining ligament to preclude primary-to-secondary leakage under MSLB differential pressure loading.

To demonstrate adequate leakage integrity of tubes with indications acceptable per the tube repair criteria, the licensee proposed to take a number of compensatory actions. Thirteen tubes containing approximately 75 volumetric indications were selected for in-situ pressure testing during the Refuel 10 outage. Sections of tube were pressurized to the pressurizer relief valve setpoint plus additional margins to account for valve accumulation, variability in tube material properties, and temperature-induced effects. Tubes selected for testing were determined based on those tubes that contained the indications with the highest bobbin coil voltage and the lowest axial and circumferential extent as measured by MRPC inspection. Since bobbin coil voltage is related to degradation volume for similar defects, the greater the voltage the higher the indication volume. By selecting tubes containing indications with minimal axial and circumferential extent, the licensee attempted to test those tubes which contain degradation with the most extensive through-wall penetration.

The licensee submitted the results of the in-situ pressure testing by letter dated April 8, 1996. No measurable leakage was detected in any of the in-situ leakage tests. These tests demonstrate that a number of tubes containing indications near the proposed voltage repair limit have adequate leakage margins as of the Refuel 10 outage. As discussed previously in Section 4.2, the first span indications are experiencing limited, if any, voltage growth between inspections. Therefore, the NRC staff agrees with the licensee's conclusion that these tubes will retain adequate leakage margins until the next refueling outage. The licensee has committed to complete additional in-situ pressure tests at the next refueling outage as a means to verify continued leakage integrity of tubes containing first span indications.

To provide defense-in-depth assurance of leakage integrity, the licensee has proposed a reduction in the allowable primary-to-secondary leakage to 150 gpd through any one steam generator from the current 1 gpm (1440 gpd) through both steam generators. In addition, the licensee has recently installed main steam line N-16 monitors. These primary-to-secondary leakage monitors would be expected to provide an early indication of tube leakage which would enable timely unit shutdown in the event of significant leakage.

Based on an analysis of design basis loading conditions, the CR-3 steam generator tubes should have adequate primary-to-secondary leakage integrity provided IGA degradation depths are less than 87 percent through-wall. Although a proposed quantitative methodology relating eddy current voltage measurements to degradation depth has not been achieved at this time, the licensee has taken additional measures to minimize the potential for tube leakage over the next operating cycle. These measures include: (1) improvements to leakage monitoring will facilitate the rapid detection of potential through-wall defects during operation; (2) previous pulled tube data suggests that the population of IGA defect depths have sufficient remaining

ligament to minimize the potential for burst during an MSLB; (3) in-situ pressure testing during the Refuel 10 outage demonstrated adequate leakage margins for 13 tubes containing approximately 75 detected first span indications; (4) given that the bobbin coil voltage generally increases with the size of volumetric defects, the proposed bobbin voltage repair limits should result in larger IGA defects being removed from service during the Refuel 10 outage; and (5) the low growth rate associated with first span IGA indications will minimize the potential for an increase in the number of defects that could challenge the leakage integrity of a tube during all postulated pressure loading conditions. In addition, an MSLB resulting in primary-to-secondary differential pressures that could challenge deeper IGA tube degradation is a low frequency event. On the bases listed above, the NRC staff concludes that the licensee's proposed repair criteria and compensatory measures are acceptable for operation through the end of Cycle 11.

5.0 DISCUSSION OF POTENTIAL LONG-RANGE ISSUES

During the course of the evaluation of the proposed amendment, the NRC staff and the licensee were unable to resolve all issues regarding the use of empirically derived voltage limits to ensure the depth of penetration of all in-service indications was less than the calculated allowable minimum tube wall thickness to maintain adequate leakage integrity margins. The 1.25 volt repair limit was derived, in part, using data obtained during field inspections. For a dormant (i.e., not growing) indication, the measured eddy current bobbin voltage may differ between subsequent inspections due to one or more of the following sources of variability: (1) bobbin probe wear, (2) calibration practices and standards, (3) differences in data acquisition hardware, and (4) data analyst uncertainty. A full assessment of the level of NDE uncertainty could not be completed in time to support the proposed amendment. As such the licensee could not demonstrate quantitatively at a high confidence level that inservice IGA indications with voltages less than the proposed repair limit would have through-wall depths less than the required margins to support leakage integrity under accident loading conditions. As such, the licensee proposed the additional measures discussed above to demonstrate leakage integrity.

The NRC staff notes that prior to approving this or similar repair criteria on a long-term basis, the repair criteria issues discussed previously in this Safety Evaluation should be fully addressed and incorporated into the bases for the repair criteria. In addition the NRC staff has identified a number of continuing measures that would be necessary to implement a voltage/dimensional based repair criteria for the CR-3 volumetric indications. These measures include the following: (1) long-range plans to monitor the morphology of first span IGA indications through tube pulls and destructive examinations; (2) a quantitative assessment of potential end-of-cycle leakage incorporating a bounding IGA degradation growth rate; (3) a TS requirement for inspecting tubes with confirmed indications of degradation; and (4) continued in-situ pressure testing of tubes with indications acceptable per the repair criteria to verify the leakage integrity of tubes. These items may have to be augmented depending upon the outcome of these efforts.

6.0 CONCLUSIONS REGARDING PROPOSED REPAIR CRITERIA

The licensee has proposed an alternate steam generator tube repair criteria to address a degradation mechanism unique to the CR-3 steam generators. The proposed one cycle amendment permits volumetric indications located above the top of the lower tubesheet and below the first tube support plate to remain in service based on specific criteria applying to the bobbin coil and MRPC inspection data. Accordingly, the licensee proposed to revise TS 5.6.2.10, OTSG [once-through-steam-generator] Tube Surveillance program, Acceptance criteria, for inspecting the tubes, identifying and dispositioning degraded tubes, and TS 3.4.12, RCS [reactor coolant system] Operational LEAKAGE, for limiting the primary to secondary leakage to 150 gpd through any one steam generator. The proposed TS changes also revise TS 5.7.2, Special Reports, for reporting requirements relating to tubes plugged, assessment of crack-like indications and results of in-situ pressure testing. Based on the above evaluation, the NRC staff concludes that for the next cycle of operation the structural and leakage integrity margins are adequate for tubes with confirmed indications below the first tube support plate and the secondary face of the lower tubesheet dispositioned per the voltage/dimensional repair criteria proposed by the licensee, and therefore, the proposed TS changes are acceptable for Refuel 11.

7.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Florida State official was notified of the proposed issuance of the amendment. The State official had no comments.

8.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (61 FR 13888). The amendment also changes reporting or record keeping requirements. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) and (c)(10). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

9.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: P. Rush, DE/EMCB

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