Docket File

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

October 4, 1999

Mr. C. Randy Hutchinson
Vice President, Operations ANO
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT NO. 1 - ISSUANCE OF AMENDMENT RE: ALTERNATE REPAIR CRITERIA FOR FLAWED TUBES THAT HAVE EXPERIENCED OUTER DIAMETER INTERGRANULAR ATTACK (TAC NO. MA4761)

Dear Mr. Hutchinson:

The Commission has issued the enclosed Amendment No. 202 to Facility Operating License No. DPR-51 for the Arkansas Nuclear One, Unit No. 1. The amendment consists of changes to the Technical Specifications (TSs) in response to your application dated May 14, 1999 (1CAN059901), as supplemented by letters dated June 17, 1999 (1CAN069905), September 7, 1999 (1CAN099901), September 15, 1999 (1CAN099902), September 17, 1999 (1CAN099905), and September 24, 1999 (1CAN099906).

The amendment revises the TS requirements affecting the surveillance criteria for that portion of the once-through steam generator tubes regarded as a primary-to-secondary pressure boundary located within the upper tubesheet and impacted by a specific degradation mechanism, namely, outside diameter intergranular attack.

In preparation for refueling outage 1R15, you submitted six applications requesting action on the part of the staff, four TS amendments and two relief requests. In no case did you allow for the customary 6-month review period between your submittal date and the date for which you requested action by the staff. As a result, four of your six applications were approved by the Commission immediately proceding or during refueling outage 1R15. Completion of these items required special prioritization and handling in order to accommodate your outage schedule. Furthermore, two additional items were identified during refueling outage 1R15 where you requested action on the part of the staff. The first item was a TS amendment for a steam generator tube repair criteria that was submitted as an exigent request. This amendment request was later withdrawn, at your discretion, after a considerable expenditure of resources on the part of the staff. The second item was a relief request to authorize an alternative repair for a flaw identified in the casing for the loop B low pressure injection (LPI) pump. This flaw was identified in conjunction with a system pressure test conducted during the refueling outage.

The staff recognizes that the need for a relief request to repair the flaw in the LPI pump could not have been anticipated. However, the staff has concluded that the scheduling issues associated with the other seven items were within your control. The staff has identified that resource limitations may have played a significant factor in the deficiencies described above. In addition, the staff has identified technical weaknesses associated with some of your applications which required either follow-up submittals or protracted discussions to resolve.

DFO1

The staff has identified a negative trend in these two areas and has determined that it should be brought to your attention.

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

Sincerely,

ORIGINAL SIGNED BY

M. Christopher Nolan, Acting Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosures: 1. Amendment No. 202 to DPR-51
2. Safety Evaluation

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

ENTERGY OPERATIONS INC.

DOCKET NO. 50-313

ARKANSAS NUCLEAR ONE, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 202
License No. DPR-51

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

   A. The application for amendment by Entergy Operations, Inc. (the licensee) dated May 14, 1999, as supplemented by letters dated June 17, 1999, September 7, 1999, September 15, 1999, September 17, 1999, and September 24, 1999, 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 license 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-51 is hereby amended to read as follows:

   2. Technical Specifications

      The Technical Specifications contained in Appendix A, as revised through Amendment No. 202 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. The license amendment is effective as of its date of issuance and shall be implemented prior to startup from the Unit 1 Cycle 15 refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION

Robert A. Gramm, Chief, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: October 4, 1999

ATTACHMENT TO LICENSE AMENDMENT NO. 202

FACILITY OPERATING LICENSE NO. DPR-51

DOCKET NO. 50-313

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

Remove	Insert
110j1	110j1
110k	110k
110l	110l
110m	110m
110m1	110m1
110m2	--
110n	110n

a. The first sample inspection during each inservice inspection (subsequent to the baseline inspection) of each steam generator shall include:

1. All nonplugged tubes that previously had detectable wall penetrations (>20%), except tubes in which the wall penetration has been spanned by a sleeve, and

2. At least 50% of the tubes inspected shall be in those areas where experience has indicated potential problems, except where specific groups are inspected per Specification 4.18.3.a.3.

   A tube inspection (pursuant to Specification 4.18.5.a.9) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

3. Tubes in the following groups may be excluded from the first random sample if all tubes in a group in both steam generators are inspected. The inspection may be concentrated on those portions of the tubes where imperfections were previously found. No credit will be taken for these tubes in meeting minimum sample size requirements. Where only a portion of the tube is inspected, the remainder of the tube will be subjected to the random inspection.

   (1) Group A-1: Tubes within one, two or three rows of the open inspection lane.

   (2) Group A-2: Unplugged tubes with sleeves installed.

   (3) Group A-3: Tubes in the wedge-shaped group on either side of the lane region (Group A-1) as defined by Figure 4.18.1.

4. Tubes with axially-oriented tube end cracks (TEC) which have been left inservice for the previous cycle shall be inspected with a rotating coil eddy current technique in the area of the TEC and characterized in accordance with topical report BAW-2346P, Rev.0, during all subsequent SG inspection intervals pursuant to 4.18.4. The results of this examination may be excluded from the first random sample. Tubes with axial TECs identified during previous inspections which meet the criteria to remain in service will not be included when calculating the inspection category of the OTSG.

5. Implementation of the upper tubesheet ODIGA alternate repair criteria requires a 100% bobbin coil inspection of the non-plugged and non-sleeved tubes, spanning the defined region of the upper tubesheet, during all subsequent SG inspection intervals pursuant to 4.18.4. Tubes with ODIGA identified during previous inspections which meet the criteria to remain in service will not be included when calculating the inspection category for the OTSG. The defined region begins one inch above the upper tubesheet secondary face and ends at the nearest tube roll transition. ODIGA indications detected by the bobbin coil probe shall be characterized using rotating coil probes in accordance with topical report BAW-10235P, Revision 1.

b. All tubes which have been repaired using the reroll process will have the new roll area inspected during the inservice inspection.

c. The second and third sample inspections during each inservice inspection as required by Table 4.18-2 may be less than a full tube inspection by concentrating the inspection on those areas of the tube sheet array and on those portions of the tubes where tubes with imperfections were previously found.

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

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.

NOTES: (1) In all inspections, previously degraded tubes whose degradations have not been spanned by a sleeve must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

(2) Where special inspections are performed pursuant to 4.18.3.a.3, defective or degraded tubes found as a result of the inspection shall be included in determining the Inspection Results Category for that special inspection but need not be included in determining the Inspection Results Category for the general steam generator inspection.

(3) Where special inspections are performed pursuant to 4.18.3.b, defective or degraded tube indications found in the new roll area as a result of the inspection and any indications found above the new roll area, are not included in the determination for the inspection results category of a general steam generator inspection.

4.18.4 Inspection I rvals

The above-required inservice inspections of steam generator tubes shall be performed at the following frequencies:

a. The baseline inspection shall be performed during the first refueling shutdown. Subsequent inservice inspections shall be performed at intervals of not less than 10 nor more than 24 calendar months after the previous inspection. If the results of two consecutive inspections for a given group* of tubes following service under all volatile treatment (AVT) conditions fall into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval for that group may be extended to a maximum of 40 months.

b. If the results of the inservice inspection of a steam generator performed in accordance with Table 4.18-2 at 40-month intervals for a given group* of tubes fall in Category C-3, subsequent inservice inspections shall be performed at intervals of not less than 10 nor more than 20 calendar months after the previous inspection. The increase in inspection frequency shall apply until a subsequent inspection meets the conditions specified in 4.18.4.a and the interval can be extended to 40 months.

c. Additional unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.18-2 during the shutdown subsequent to any of the following conditions:

1. Primary-to-secondary leakage in excess of the limits of Specification 3.1.6.3.b (Inservice inspection not required if leaks originate from tube-to-tubesheet welds). If the leaking tube is from either Group A-1 or A-3 as defined in Specification 4.18.3.a.3, all of the tubes in the affected group in this steam generator may be inspected in lieu of the first sample inspection specified in Table 4.18-2. If the degradation mechanism which caused the leak is limited to a specific portion of the tube length, the inspection per this paragraph may be limited to the affected portion of the tube length. If the results of this inspection fall into the C-3 category, all of the tubes in the same group in the other steam generator will also be similarly inspected.

   If the leaking tube has been repaired by the reroll process and is leaking in the new roll area, all of the tubes in the steam generator that have been repaired by the reroll process will have the new roll area inspected. If the results of this inspection fall into the C-3 category, all of the tubes with rerolled areas in the other steam generator will also be similarly inspected. This inspection will be in lieu of the first sample inspection specified in Table 4.18-2.

2. A seismic occurrence greater than the Operating Basis Earthquake,

3. A loss-of-coolant accident requiring actuation of the engineered safeguards, or

4. A main steam line or feedwater line break.

*A group of tubes means: (a) All tubes inspected pursuant to 4.18.3.a.3, or
(b) All tubes in a steam generator less those inspected pursuant to 4.18.3.a.3.

4.18.5 Acceptance Criteria

a. 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. Eddy current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

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

4. Degraded Tube means a tube containing imperfections ≥ 20% of the nominal wall thickness caused by degradation, except where all 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 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.

7. Plugging Limit means the imperfection depth at or beyond 40% of the nominal tube wall thickness for which the tube shall be sleeved, rerolled, or removed from service because it may become unserviceable prior to the next inspection. This does not apply during Cycle 16 to ODIGA indications within the defined region of the upper tubesheet. These indications shall be assessed for continued plant operation in accordance with topical report BAW-10235P, Revision 1.

Axially-oriented TEC indications in the tube that do not extend beyond the adjacent cladding portion of the tube sheet into the carbon steel portion are not included in this definition. These indications shall be assessed for continued plant operation in accordance with topical report BAW-2346P, Rev. 0.

The reroll repair process will only be used to repair tubes with defects in the upper tubesheet area. The reroll repair process will be performed only once per steam generator tube using a 1 inch roll length. The new roll area must be free of detectable degradation in order for the repair to be considered acceptable. The reroll repair process is described in the topical report, BAW-10232P, Revision 00.

8. 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 steam line or feedwater line break as specified in Specification 4.18.4.c.

9. Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit. For tubes that have been repaired by the reroll process within the upper tubesheet, that portion of the tube above the new roll can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed.

b. The steam generator shall be determined operable after completing the corresponding actions (plug, reroll, or sleeve all tubes exceeding the plugging limit and all tubes containing non-TEC through-wall cracks) required by Table 4.18-2.

4.18.6 Reports

Following each inservice inspection of steam generator tubes, the complete results of the inspection shall be reported to the NRC. This report, to be submitted within 90 days of inspection completion, shall include:

a. Number and extent of tubes inspected;

b. Location and percent of wall-thickness penetration for each indication of an imperfection;

c. Identification of tubes plugged and tubes sleeved;

d. Number of tubes repaired by rerolling and number of indications detected in the new roll area of the repaired tubes;

e. Summary of the condition monitoring and operational assessment results when applying TEC alternate repair criteria; and

f. Summary of the condition monitoring and the operational assessment results (including growth) when applying the upper tubesheet ODIGA alternate repair criteria.

This report shall be in addition to a Special Report (per Specification 6.12.5.d) required for the results of steam generator tube inspections which fall into Category C-3 as denoted in Table 4.18-2. The Commission shall be notified of the results of steam generator tube inspections which fall into Category C-3 prior to resumption of plant operation. The written Special Report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

Bases

The surveillance requirements for inspection of the steam generator tubes ensure that the structural integrity of this portion of the RCS will be maintained. The program for inservice inspection of steam generator tubes is based on a modification of Regulatory Guide 1.83, Revision 1. Inservice inspection of steam generator tubing is essential in order to maintain surveillance of the conditions of the tubes in the event that there is evidence of mechanical damage or progressive degradation due to design, manufacturing errors, or inservice conditions that lead to corrosion. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken.

In general, steam generator tubes that are degraded beyond the repair limit can either be plugged, sleeved, or rerolled. The steam generator (SG) tubes that are plugged are removed from service by the installation of plugs at both ends of the associated tube and thus completely removing the tube from service. When the tube end cracking (TEC) alternate repair criteria is applied, axially-oriented indications found not to extend from the tube sheet cladding region into the carbon steel region may be left in service under the guidelines of topical report BAW-2346P, Rev. 0. When the upper tubesheet outer diameter intergranular attack (ODIGA) alternate repair criteria is applied, indications found within the defined region of the upper tubesheet may be left in service under the guidelines of topical report BAW-10235P, Revision 1. The defined region begins one inch above the upper tubesheet secondary face and ends at the nearest tube roll transition. Following a SG inspection, an operational assessment is performed to ensure primary-to-secondary leak rates will be maintained within the assumptions of the accident analysis.

Degraded steam generator tubes can also be repaired by the installation of sleeves which span the area of degradation and serve as a replacement pressure boundary for the degraded portion of the tube, thus permitting the tube to remain in service.

Degraded steam generator tubes can also be repaired by the rerolling of the tube in the upper tubesheet to create a new roll area and pressure boundary for the tube. The rerolling methodology establishes a new pressure boundary below the degradation, thus permitting the tube to remain in service. The degraded tube above the new roll area can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed in the upper tubesheet. The rerolling repair process will only be used to repair defects in the upper tubesheet in accordance with BAW-10232P, Revision 00.

All tubes which have been repaired using the reroll process will have the new roll area inspected during future inservice inspections. Defective or degraded tube indications found in the new roll and any indications found in the original roll need not be included in determining the Inspection Results Category for the generator inspection.

The reroll repair process will only be used to repair tubes with defects in the upper tubesheet area. The reroll repair process will be performed only once per steam generator tube using a 1 inch roll length. Thus, multiple applications of the reroll process to any individual tube is not acceptable. The new roll area must be free of detectable degradation in order for the repair to be considered acceptable. After the new roll area is initially deemed acceptable, future degradation in the new roll area will be analyzed to determine if the tube is defective and needs to be removed from service. The reroll repair process is described in the topical report, BAW-10232P, Revision 00.

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 202 TO

FACILITY OPERATING LICENSE NO. DPR-51

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT NO. 1

DOCKET NO. 50-313

1.0 INTRODUCTION

By letter dated May 14, 1999 (1CAN059901), as supplemented by letters dated June 17, 1999 (1CAN069905), September 7, 1999 (1CAN099901), September 15, 1999 (1CAN099902), September 17, 1999 (1CAN099905), and September 24, 1999 (1CAN099906), Entergy Operations, Inc. (the licensee), submitted a request for changes to the Arkansas Nuclear One, Unit No. 1, Technical Specifications (TSs). The requested changes would allow once-through steam generator tubes (OTSGs) with confirmed volumetric indications within the upper tubesheet to remain in service during cycle 16. The licensee has proposed to revise TS 4.18.5.a.7 to incorporate by reference acceptance criteria to allow steam generator tubes to remain in service during cycle 16 with indications of outer diameter intergranular attack (ODIGA) in the upper tubesheet region of the steam generators. In addition, the licensee's submittal dated September 17, 1999, included additional clarification of its commitments to assess ODIGA degradation in support of the proposed amendment.

Given that the licensee initiated a refueling outage at ANO-1 on September 10, 1999, the licensee and the NRC were unable to fully resolve all technical differences in order to support the permanent approval of the proposed amendment. As such, the repair criterion considered herein are applicable only for operation during cycle 16. The absence of a repair criteria to address the ODIGA degradation would require the repair or plugging of a significant number of steam generator tubes during the outage.

The letters dated June 17, 1999, September 7, 1999, September 15, 1999, September 17, 1999, and September 24, 1999, provided clarifying information that was within the scope of the original application and did not change the staff's initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

The existing depth-based steam generator tube repair limit (40 percent throughwall) in the ANO-1 TSs attempts to ensure adequate tube integrity through the end of the next operating cycle. The licensee has proposed alternate criteria that include additional inservice inspection, consideration of flaw structural limits based on length rather than depth, and reliance on results of in-situ pressure testing to demonstrate adequate leakage integrity margins. These criteria

would allow tubes with ODIGA indications to remain in service through cycle 16. The proposed TS mandates the performance of bobbin and rotating probe eddy current inspections in the upper tubesheet region, references Framatome Technologies, Inc. (FTI) Topical Report BAW-10235P, "Management Program for Volumetric Outer Diameter Intergranular Attack in the Tubesheets of Once-Through Steam Generators," Revision 1, as the repair criteria applicable to ODIGA degradation and requires the licensee to submit a summary of its condition monitoring and operational assessment results for the ODIGA degradation. In addition, the licensee will perform in-situ pressure testing if growth is detected from an assessment of Plus Point voltage amplitude measurements obtained in the 1R14 and 1R15 outages. The sample size would be defined such that leakage through IGA indications would, with a 95 percent confidence, be less than 1 gpm during a main steam line break (MSLB).

The ANO-1 TSs require that tubes having degradation greater than 40 percent throughwall be repaired or removed from service. During the steam generator tube inspection in the refueling outage in September 1996 (1R13), the licensee used an eddy current (EC) bobbin probe to size the depth of indications in the upper tubesheet that were attributed to ODIGA. Prior to the inspection, the licensee had qualified an EC sizing technique specifically for measuring the depth of the IGA indications. As a result of the inspection, a number of tubes with IGA indications were returned to service because the depths of the indications were measured to be less than the tube repair limit in the TS. Those IGA indications measured during 1R13 that were thought to exceed the 40 percent throughwall criteria were removed from service during that outage.

During the 1R13 outage, the licensee removed three tubes containing a total of 11 IGA indications for destructive examinations. The tubes were selected on the basis of indications that bounded the IGA degradation of the tubes that were left in service. After performing burst tests that subjected the tubes to pressures well in excess of normal operating pressures, the licensee compared the actual depths of the IGA degradation measured by destructive examinations to the depths predicted by the EC sizing technique used during the tube inspection program. The comparison uncovered a systematic nonconservatism in the EC sizing technique. The discrepancy in the IGA measurements and predications raised concerns that some of the tubes left in service actually had IGA degradation that exceeded the TS repair criteria of 40 percent throughwall.

When the noncompliance was identified, the licensee requested and was granted a notification of enforcement discretion (NOED) on April 9, 1997. The basis for the NOED was that, although some of the IGA indications could exceed the 40 percent throughwall repair criteria, confidence in the structural and leakage integrity of the tubes was provided by the burst tests performed, the performance history of the tubes at ANO-1, and the added support provided by the upper tubesheet. The licensee submitted an exigent TS change on April 11, 1997, to allow a one-time exception to the surveillance requirements of Section 4.18.5.b. This exception allowed tubes with ODIGA indications within the upper tubesheet with potential throughwall depths greater than the plugging limit to remain in service for the remainder of cycle 14. The April 11, 1997, submittal was supplemented on May 2, 1997, with an additional TS change which reduced the leakage limit through the steam generator tubes from 500 gallons per day (gpd) to 144 gpd for the remainder of cycle 14. In response to this request, the NRC issued Amendment No. 189 to the ANO-1 license dated May 7, 1997. This amendment allowed the unit to continue operation through the remainder of cycle 14 with tubes that had potential throughwall defects in excess of the 40 percent plugging limit.

Prior to 1R13, the Babcock and Wilcox Owners Group (B&WOG) was working on the development of an alternate repair criteria (ARC) for volumetric ODIGA flaws. In response to the events at ANO-1, the B&WOG expedited its schedule and focused its initial work on volumetric ODIGA indications within the tubesheet. ANO-1 is the lead plant for NRC review of proposed TS changes associated with the implementation of the ARC. A submittal was transmitted on August 13, 1997, which included a general steam generator description and discussion of plant chemistry, flaw morphology of pulled tubes, nondestructive examination of pulled tubes, and a comparison of laboratory developed ODIGA and field ODIGA. A second submittal was made on December 12, 1997, with a request for approval for use during 1R14 which began on March 28, 1998.

Through discussions between the licensee and the NRC staff during March 1998, it was determined that insufficient time was available to resolve outstanding issues related to the ARC prior to 1R14. Since many of the arguments that supported allowing the tubes with ODIGA flaws to remain in service during cycle 14 remained valid for operation during cycle 15, the licensee decided to strengthen the technical justification for allowing the tubes with tubes with ODIGA indications to remain in service and pursue a one-cycle TS change. The proposed change allowed ODIGA flaws in the upper tubesheet to remain in service during cycle 15 while resolution of the outstanding issues related to the previously submitted ARC proposal are pursued.

The licensee proposed to assess ODIGA growth during the previous operating cycle and use in-situ pressure testing to demonstrate that tubes would not leak under accident conditions. If no growth is detectable, the licensee will assume that growth is not likely to occur in the next cycle of operation. The licensee determined that the ODIGA indications did not grow during cycle 14. Therefore, the licensee was able to demonstrate using the results of the in-situ pressure test program that adequate leakage integrity margins are likely to exist for the duration of the next operating cycle.

Entergy submitted a license amendment to address ODIGA degradation in the upper tubesheet region identified during the 1R15 outage that was similar to the amendment proposed prior to the 1R14 outage. The primary difference between the new license amendment request and the prior request was that the licensee could rely on the in-situ pressure test results obtained during the prior refueling outage if the ODIGA degradation did not grow during cycle 15. In addition, the NRC staff would independently review data to assess ODIGA growth rates for its evaluation of the proposed license amendment.

3.0 EVALUATION

3.1 Inservice Inspection of Steam Generator Tubes

The inservice inspection scope for the current ANO-1 refueling outage includes an examination of 100 percent of the steam generator tubes in the upper tubesheet region with a bobbin coil eddy current probe. Tube examinations with this probe are expected to should identify indications of ODIGA degradation that could degrade the tube structural and leakage integrity margins. The bobbin probe, however, cannot assess the morphology or size of detected indications. Because the proposed TS criteria for allowing tubes to remain in service apply only to ODIGA degradation, the licensee will inspect all indications detected with a bobbin coil probe

using rotating eddy current probes. These rotating probe examinations can confirm that the morphology of bobbin indications is volumetric, is indicative of ODIGA. In addition, the data acquired in the rotating probe inspections can be used to assess the axial and circumferential length of confirmed tube degradation, and whether it initiated from the inside or outside diameter of the tube.

IGA degradation is characterized as a mode of degradation that is volumetric rather than crack-like in nature. That is, the degradation affects a small volume of tube material and typically has dimensions that extend axially, circumferentially, and radially (depth) in the tube. The ODIGA degradation is expected to exhibit a morphology that extends both along the tube axis and around the circumference. Crack-like indications, however, extend primarily along only two tube directions (i.e., radial/axial, radial/circumferential). Because rotating probes are sensitive to degradation extending in both the axial and circumferential directions, these probes are capable of providing data to allow determination of whether an indication is crack-like or volumetric. In addition, they possess the capability to size the length of steam generator tube degradation. The licensee will inspect all indications detected by bobbin coil with a rotating probe that includes both Plus Point and pancake coils. This will enable the licensee to confirm the mode of the degradation, measure the Plus Point coil voltage amplitude response from the degradation, and determine the axial and circumferential length of the indication, if applicable. The staff finds that the proposed inspections are adequate to define the ODIGA indications on which the in-situ testing program will be based.

3.2 Structural Integrity Assessment

The existing TS requirements specify that tubes shall be repaired or removed from service when degradation exists within the tube that is equal to or greater than 40 percent of the nominal tube wall thickness. In order to address the acceptability of tubes with confirmed ODIGA degradation, the proposed one-cycle amendment would allow tubes with ODIGA degradation to remain in service based on the performance of the additional inspections noted in Section 3.1, imposing alternate structural acceptance criteria to the depth-based requirements currently in the TSs, and demonstration of no growth for the population of ODIGA indications in the ANO-1 OTSGs over the previous operating cycle. The proposal would allow tubes with ODIGA indications to remain in service only in the area defined to be within the upper tubesheet located by eddy current inspection between 1-inch above the secondary face and below the roll transition. The 1-inch exclusion zone above the tubesheet secondary face was established to ensure proper characterization of indications detected during the eddy current inspections.

The licensee has performed burst tests to demonstrate that the diametral clearance between the tube and adjacent tubesheet prevents tubes with simulated ODIGA flaws from deforming sufficiently to cause burst. The burst test program consisted of nine tubes containing drilled throughwall holes up to 0.5 inch in diameter and one tube containing no defects. All tubes with the laboratory defects were tested within a simulated tubesheet. Nine of the specimens burst at pressures greater than 10,941 psig. Each tube burst outside the tubesheet within the non-defected portion of the tubes. Testing problems limited the maximum pressure for one test to 9,577 psig, at which the tube had not yet burst. The burst test results indicate that the tubesheet provides sufficient support to preclude tube burst within the tubesheet. The licensee submitted a description of the test program and discussion of this conclusion in Topical Report

BAW-10226P, "Alternate Repair Criteria for Volumetric Outer Diameter Intergranular Attack in the Tubesheets of Once-Through Steam Generators," Revision 0, submitted August 13, 1997.

In the 1R14 outage, the licensee completed in-situ pressure testing of tubes containing 40 ODIGA indications. Tubes were pressurized to a pressure of 2900 psig, which is in excess of pressures expected to occur during an MSLB accident. Because the peak accident-induced loads for steam generator tubing are largely a result of thermally induced stresses rather than internal tube pressure, in-situ pressure tests on 36 of the 40 ODIGA indications imposed axial tube loads in conjunction with the internal pressure. These loads could challenge the structural or leakage integrity of tubes containing circumferentially oriented degradation of significant length or depth. None of the tubes with indications tested under these conditions leaked. The licensee subjected the four remaining ODIGA indications that were in-situ pressure tested to internal pressure loads only. However, the maximum internal pressure imposed during the testing was 6500 psig, more than 2.5 times the MSLB differential pressure. No leakage was detected from tubes with these indications during the tests.

To minimize the potential for structural failure of tubes with ODIGA degradation, the licensee has proposed to remove from service those tubes containing degradation expected to exceed length-based repair limits included in BAW-10235P, Revision 1. The length limits will require the licensee to remove from service tubes with ODIGA flaws that exceed 0.5 inch in length in either the axial or circumferential direction of the tube. Tube structural failure due to axially oriented flaws in the upper tubesheet region is precluded by the presence of the tubesheet. Tubes with circumferential flaws, however, could fail due to axial tube loads. Testing completed by the licensee indicates that throughwall flaws with circumferential extents up to 140° (0.72 inch) will have structural margins commensurate with the margins specified in Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR [Pressurized-Water Reactor] Steam Generator Tubes." Limiting ODIGA flaws to less than 0.5 inch in circumferential length will provide additional margin to account for uncertainty in measuring the flaw with nondestructive testing methods. The staff concludes that the proposed length-based repair limits are adequate to ensure that tube structural integrity margins will be maintained in accordance with guidance provided in RG 1.121.

The staff notes that tubes with volumetric IGA degradation in steam generators at other PWR facilities have also shown significant margins for structural and leakage integrity. Burst tests of tubes removed from service with IGA indications have shown significant margins for structural and leakage integrity under postulated accident conditions. In addition, the licensee for ANO-1 has not attributed any measurable operational leakage in the steam generators to the presence of ODIGA degradation in the tubing. The licensee also has extensive testing data from in-situ pressure tests completed in the 1R14 outage that indicates that this mode of degradation does not significantly degrade the structural margins of the OTSG tubing. On the basis of the conservatism in the length-based repair limits and the empirical data indicating a low likelihood of burst for ODIGA degradation, the staff concludes that the proposed amendment will ensure that the structural margins for OTSG tubing with ODIGA degradation will be maintained in cycle 16.

3.3 Demonstration of Leakage Integrity Margins

The existing depth-based repair criteria are established to ensure steam generator tubes have adequate structural and leakage integrity with appropriate margins of safety under normal

operating and postulated accident conditions. The approach proposed by the licensee may permit tubes containing degradation with actual depths greater than the 40 percent depth to remain in service. Under high differential pressures, this degradation could become a leak path for the reactor coolant to the steam generator secondary side. The licensee will rely on previously completed in-situ pressure testing of steam generator tubes with ODIGA indications and an assessment of ODIGA growth rates to demonstrate a low leakage potential for tubes containing this mode of degradation. The growth rate study must conclude that there is a low likelihood that the ODIGA degradation grew during the previous cycle of operation in order for the licensee to use the in-situ pressure test results obtained in the 1R14 outage. Detection of flaw growth will necessitate the performance of additional in-situ pressure testing in the 1R15 outage to reassess tube leakage integrity margins.

In-situ pressure testing subjects degraded tubes to conditions that are conservative with respect to internal pressure loadings postulated to occur under accident conditions. Internal pressure within the tube during the test induces axial and circumferential stresses within the tube wall. The purpose of the testing is to assess whether the degraded tubes exposed to these elevated stresses are capable of withstanding the test conditions while retaining leakage and structural integrity. There is a substantial database that indicates that leakage from ODIGA degradation is unlikely to occur. Destructive examinations of the ODIGA patches in tubes removed in 1R13 showed none of the flaws to be throughwall. The licensee has also completed testing of tubes with holes of various sizes and depths machined into the tubing. The artificial patches were machined to depths ranging from approximately 84 percent to 95 percent throughwall, with patch diameters of 0.30 and 0.50 inch. The severity of the machined patches bound the potential effects of having an ODIGA patch in a tube that is of similar depth and diameter. None of the machined patches showed signs of leakage when subjected to accident loads.

To augment the existing database of pulled tubes and machined IGA defects, the licensee developed artificial IGA flaws under laboratory conditions. The defects in these tubes were corrosively-induced rather than mechanically induced in order to more closely simulate the degradation found in the actual steam generator tubes. The licensee subjected a total of 29 simulated IGA defects to design-basis loading conditions. The sizes of these defects bounded those of the ODIGA flaws presently in the ANO-1 OTSG tubing. All of the tube specimens retained structural and leakage integrity at the target test conditions.

The licensee reports that there have been no known primary-to-secondary leaks in the history of ANO-1 attributed to volumetric ODIGA indications despite the fact that many of these indications have remained in service for years. In addition, during a May 1996 plant transient, the "B" steam generator tubing was subjected to a differential pressure of approximately 2100 psid for several hours. No leakage from ODIGA flaws was observed during the event or following plant startup.

The licensee implemented an ODIGA repair criteria in 1R14 that required in-situ pressure testing a number of tubes with ODIGA indications. The objective of the testing was to demonstrate a 0.95 probability at a 95 percent confidence level that the total leakage from ODIGA indications would not exceed 0.5 gallon per minute (gpm) during an MSLB accident. By testing the integrity of a representative sample of tubes, the licensee could assess the potential for leakage from all of the tubes identified by the eddy current inspections to have ODIGA indications. The total leak rate from this effort was calculated rather than measured. The licensee assumed for this calculation a total ODIGA axial flaw length of 0.3 inch that is

throughwall over 50 percent of the length. The leak rate was analytically determined using a computer program. The licensee then calculated a hypothetical leak rate consistent with the conditions for an MSLB. The licensee estimated a leak rate of 0.0185 gpm through the assumed flaw geometry. Assuming that the ODIGA patches could contribute approximately 0.5 gpm of the licensing-basis leak rate (1.0 gpm), 39 ODIGA patches could be assumed to leak and the current licensing-basis leak rate would be maintained. Given the maximum allowable number of leaking ODIGA patches (39) and the total number of ODIGA indications that were identified during the inspections to be performed during 1R14, the licensee statistically determined the number of tubes to be in-situ tested. As indicated in Section 3.2 of this safety evaluation, the licensee tested 40 ODIGA indications during the outage, and no leakage was detected during any of these tests.

The licensee proposed to assess the leakage integrity of ODIGA degradation during the 1R15 outage in a manner similar to that conducted in 1R14. The primary difference between the two assessments is that the licensee may rely on the results of the in-situ pressure testing completed in 1R14 provided no ODIGA growth is observed between the 1R14 and 1R15 outages. The absence of growth during cycle 15 would indicate that the integrity of the OTSG tubes with ODIGA degradation is unchanged from the previous refueling outage. Therefore, the licensee believes that conclusions made with regard to the in-situ pressure test program would remain valid. If it cannot be concluded that the ODIGA degradation did not progress in cycle 15, then the licensee proposes that it will conduct in-situ pressure testing with the same objective as completed in the 1R14 outage. If this is necessary, the licensee proposes that it will calculate the total steamline break leakage using a slightly different approach. Specifically, the licensee will calculate the leakage using a fraction of the actual measured ODIGA flaw lengths rather than an upper bound (i.e., 0.3 inch). The fraction of flaw that is assumed to be throughwall is reduced from 50 percent to 25 percent. This is based on destructive examination results of tubes removed from the ANO-1 OTSGs. The overall number of flaws assumed to exist in the population is also adjusted for the sensitivity of the inspection method (i.e., probability of detection).

One other modification from the previous repair criteria applied to the ODIGA degradation is that the total accident-induced leakage will be assessed relative to the licensing-basis leak rate limit of 1 gpm rather than 0.5 gpm. This represents a less conservative limit for leakage than previously used by the licensee. In addition, no margin exists to address leakage from other potential sources. If accident-induced leakage is expected from other sources within the ANO-1 OTSGs, then the licensee must ensure that the total leakage from all sources is less than 1 gpm in order to remain consistent with the existing licensing basis for the plant. Such an approach is embodied in Framatome Technologies, Inc. Topical Report BAW-2346P, "Alternate Repair Criteria for Tube End Cracking in the Tube-to-Tubesheet Roll Joint of Once-Through Steam Generators," Revision 0, which is incorporated by reference in the TSs.

The staff has identified shortcomings in the licensee's proposed approach for assessing leak rates for indications assumed to leak during postulated accidents. The staff notes that the leakage through ODIGA degradation is calculated using a computer code that has not been reviewed and approved for use by the NRC. In particular, the code needs to be benchmarked against actual leakage data for flawed test specimens representative of the ODIGA flaws at ANO-1. The staff notes that such data tend to exhibit significant scatter. Therefore, uncertainties associated with the leak rate estimates need to be quantified and taken into consideration to ensure they are conservative.

The staff also notes that actual leaking ODIGA flaws may exhibit through-wall components substantially longer than those assumed by the licensee which may result in nonconservative leak-rate estimates for individual flaws. Leak rates are highly sensitive to through-wall crack length. IGA and crack profiles tend to be highly variable. One acceptable approach involves determining leak rates on a crack-specific basis based on measured crack length (with appropriate allowance for measurement error).

Notwithstanding the shortcomings in the licensee's approach for assessing leak rates for tubes with indications assumed to leak, the staff believes that the licensee's estimate of total leak rate for the total population of ODIGA flaws in the faulted OTSG for the upcoming cycle 16 is conservative. This is based on the staff's finding (discussed in 3.4 below) that the ODIGA indications are no longer experiencing significant growth and the staff's belief that the licensee's estimate of the number of ODIGA flaws that may leak during postulated accidents is very conservative. Future efforts to develop an ODIGA repair criteria as a proposed permanent change to the TSs should address the aforementioned shortcomings identified by the NRC staff.

3.4 Analysis of Growth Rate for IGA Degradation

In accordance with the guidance provided in NRC RG 1.121, steam generator tube repair limits generally incorporate an allowance for degradation growth over the next cycle of operation. Such criteria account for the progression of steam generator tube flaws in length or depth during operation that could potentially degrade the margins for tube integrity below acceptable limits. The in-situ testing method for the ODIGA indications in the upper tubesheet does not utilize dimensional limits nor include an allowance for growth. Therefore, the licensee's proposal to use in-situ pressure testing during the outage is only capable of demonstrating that the population of tubes with ODIGA indications has adequate leakage integrity at the time of the test. If it can be demonstrated that the expected flaw growth rate for the ODIGA degradation is negligible, then the in-situ pressure testing will provide assurance that the affected tubes will have sufficient margins for structural and leakage integrity beyond the outage, throughout the next cycle of operation.

The licensee has previously completed a growth assessment for ANO-1 eddy current bobbin indications. The change in bobbin voltage amplitude from 1993-1996 was determined for 129 upper tubesheet indications. The results show that the average voltage change per effective full power year is "zero." The licensee attributed the variability about this average to eddy current uncertainty. Of the 129 indications that were studied, 25 were removed from service during 1R13. The licensee reevaluated the growth rates for the remaining 104 ODIGA indications during the 1R14 outage. As documented in the licensee's submittal dated May 1, 1998, the assessment confirmed that there was essentially no growth for the ODIGA degradation during cycle 14.

For the 1R15 outage the licensee will reevaluate the growth of ODIGA indications in the ANO-1 OTSGs. In the previous inspections, growth rates were assessed using bobbin coil eddy current data. The 1R15 growth rate evaluation will use data obtained from rotating eddy current probes. The licensee will use pancake coil data to evaluate the length (axial and circumferential) of each indication and Plus Point coil data to assess changes in voltage amplitude. If growth is detected for two of the three parameters (axial length, circumferential

length, or voltage) for the population of indications, then the proposed repair criteria cannot be used to disposition ODIGA indications. Growth is confirmed for a parameter when the 95-percent lower confidence limit for the mean of the distribution of measured changes is greater than zero. The licensee will also apply criteria to identify potential growth of individual ODIGA indications. Changes in lengths or voltages of individual ODIGA indications that exceed the limits specified in BAW-10235P, Revision 1, will be removed from service.

The proposed repair criteria rely on the assumption that the ODIGA degradation growth will not occur during the subsequent operating cycle if growth was not detected in the previous operating cycle. Any changes in the size or depth of the flaws will invalidate the results of the leakage assessment. The staff was concerned that the proposed growth rate criteria are insufficient to ensure the detection of changes for the population of ODIGA indications. From a statistical standpoint, the criteria state that growth is confirmed when there is less than a 2.5-percent chance that there is no growth for two of three inspection parameters. The licensee stated that such criteria are necessary to ensure the detection of growth from data that include variability due to the inspection process. The licensee did not attempt to quantify inspection variability. However, the licensee will implement minor changes in the inspection process such as the use of a master calibration standard to minimize some of the inspection variability.

To address the staff's concerns the licensee limited the amendment to one cycle (cycle 16). In addition, the licensee will conduct in-situ pressure testing of ODIGA flaws if growth is detected. Specifically, if the voltage corresponding to the mean for the population minus one standard deviation is greater than zero, than the licensee will complete in-situ pressure testing to assess potential leakage from ODIGA indications. If this testing is performed and leakage is detected from one or more upper tubesheet ODIGA flaws, then the licensee will repair or plug all tubes containing ODIGA.

The licensee's proposed amendment requires that growth rates be evaluated using criteria to address changes in the population of ODIGA degradation and changes for individual indications. Specifically, statistical limits established using 95-percent confidence or tolerance limits are determined for assessing growth of the population of indications or individual ODIGA flaws, respectively.

On September 24, 1999, the licensee submitted to the NRC a summary of data collected for the ODIGA indications inspected during the 1R15 outage. The submittal indicated that the licensee had evaluated the data per the proposed growth rate criteria and concluded that growth was not occurring. The staff independently reviewed these data to assess any changes in the eddy current signal measurements that might be indicative of growth. The staff assessed changes in the lengths of indications (axial and circumferential) and Plus Point voltage. The staff used alternate criteria to assess whether the degradation was progressing and concluded that the population of ODIGA degradation does not appear to be growing. Therefore, the licensee's conclusion appears to be correct.

Although the staff agrees that there is no significant growth occurring at this time, the staff believes that the proposed criterion for making such a finding is insufficient. This criterion is defined in such a way as to indicate growth is occurring only if there is relatively high assurance that such growth is occurring. For example, a best-estimate mean growth rate higher than zero is not enough to trip the criterion. Rather, the lower one-sigma bound of the mean growth rate must exceed zero in order to trip the criterion. Future efforts to develop an ODIGA repair

criterion as a proposed permanent change to the TSs should address the NRC staff's concerns regarding the growth criterion. An adequate growth criterion should provide reasonable assurance that indicated growth would be expected to trip the criterion resulting in additional in-situ pressure tests and a revised operational assessment.

Given the absence of significant growth, the proposed contingency actions for this one-time amendment request should growth be identified are moot. However, these contingency measures will need additional technical justification should the licensee desire to propose an ODIGA repair criterion as a future permanent change to the TSs. Specifically, the licensee will need to discuss how growth will be taken into account (should it be determined to be occurring) when assessing potential accident-induced leak rates for the next end of cycle.

4.0 REQUIREMENTS FOR IMPLEMENTATION OF ODIGA REPAIR CRITERIA

The following summarizes the proposed changes to the ANO-1 TSs to implement the repair criteria for steam generator tubes degraded with ODIGA degradation:

1. TS 4.18.3.a.5

   A requirement is added to the TS to mandate the performance of inspections of all non-plugged and non-sleeved tubes in the upper tubesheet region using a bobbin coil probe. Tubes with previously identified ODIGA degradation will not be included in the inspection results category for the OTSG. All ODIGA indications identified by a bobbin probe will be inspected with a rotating coil probe in order to characterize the nature of the indications. This is an enhancement of existing TS requirements and is acceptable.

2. TS 4.18.5.a.7

   The licensee proposes to modify the definition of "Plugging Limit" to state that the depth-based repair limit does not apply to ODIGA degradation in the upper tubesheet region during cycle 16. Tubes with these indications will be repaired in accordance with topical report BAW-10235P, Revision 1, as evaluated above. Therefore, this change is acceptable.

3. TS 4.18.5.b

   Much of TS 4.18.5.b is deleted because this TS specified the requirements for applying a repair criteria for ODIGA degradation during cycle 15. Because cycle 15 has been completed, these requirements are no longer applicable. Therefore, this change is acceptable.

4. TS 4.18.6.f

   A requirement is added to the TS to report the results of the licensee's condition monitoring and operational assessments for upper tubesheet ODIGA degradation. Therefore, this change is acceptable.

5.0 SUMMARY

The staff finds that implementation of the proposed ODIGA repair criteria is acceptable for the upcoming operating cycle (i.e., cycle 16). The staff has independently assessed the ODIGA inspection results obtained during the current outage and concurs with the licensee's finding that the subject ODIGA indications are not experiencing any significant growth. Given the absence of significant growth, the in-situ pressure tests performed during the 1R14 outage indicate that the licensee's estimate of the number of ODIGA indications that may potentially leak during postulated accidents is a conservative upper bound and that the licensee's estimate of total accident-induced leak rate is conservative. Therefore, the proposed changes to the ANO-1 TSs are acceptable to justify allowing tubes with ODIGA indications to remain in service during cycle 16 operation.

As a point of clarification, it is the staff's understanding that projected total accident-induced leak rate from all contributing degradation mechanisms (including ODIGA and tube end cracks) will be limited to 1 gpm as is stated in FTI Topical Report BAW-2346P, Revision 0, which was incorporated by reference into the TSs in Amendment No. 201.

The staff's evaluation above has identified shortcomings in the licensee's proposed change for a permanent ODIGA repair criteria. The licensee's assessment of potential accident-induced leak rates, assuming leakage occurs, has not been performed in a rigorous manner. The staff believes there is significant uncertainty associated with these estimates that has not been addressed. In addition, the staff finds that the proposed criterion for ensuring that no growth is occurring is not sufficient for this purpose. In light of these shortcomings, the staff was unable to approve this change on a permanent basis. Any future submittals regarding a proposed ODIGA repair criteria should address the technical issues raised by the staff.

6.0 STATE CONSULTATION

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

7.0 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. 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 amendment involves no significant hazards consideration, and there has been no public comment on such finding (64 FR 29709, June 2, 1999). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). 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.

8.0 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

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