December 5, 1986

Docket No. 50-313

Mr. Gene Campbell
Vice President, Nuclear
Operations
Arkansas Power and Light Company
P. O. Box 551
Little Rock, Arkansas 72203

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	C. Thomas

Dear Mr. Campbell:

The Commission has issued the enclosed Amendment No. 106 to Facility Operating License No. DPR-51 for Arkansas Nuclear One, Unit No. 1 (ANO-1). This amendment consists of changes to the Technical Specifications (TSs) in response to your application dated April 1, 1986. Supporting information was provided by letters dated August 22, October 14 and October 23, 1986.

The amendment modifies the ANO-1 TSs for steam generator surveillance to (1) allow the sleeving of steam generator tubes and (2) modify the designation of those areas identified as special groups in the steam generators where imperfections have been previously found.

The current TSs for tubes and these TS changes for tube sleeves do not address circumferential cracks. It is our understanding, based on conversations with your staff, that it is your intent to remove from service those sleeved tubes in which circumferential cracks have been detected in the sleeves. We request you confirm this in writing within 30 days from receipt of this letter.

The material contained in the enclosed Safety Evaluation is considered to be proprietary and, therefore, is withheld from public disclosure per 10 CFR 2.790. A non-proprietary version of the Safety Evaluation is also enclosed and is being made publicly available.

Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

/S/

John F. Stolz, Director
PWR Project Directorate #6
Division of PWR Licensing-B

Enclosures:
1. Amendment No. 106 to DPR-51
2. Safety Evaluation - Proprietary and Non-Proprietary Versions

cc w/Non-Proprietary Safety Evaluation:
See next page

PBD-6	PBD-6	PBD-6	PBD-6	PBD-6	OGC
RIngram	GVissing:eh	CMcCracken	GEdison	JFStolz	
12/4/86	12/4/86	12/4/86	12/4/86	12/5/86	12/05/86

No legal objection

Mr. G. Campbell
Arkansas Power & Light Company

Arkansas Nuclear One, Unit 1

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

ARKANSAS POWER AND LIGHT COMPANY

DOCKET NO. 50-313

ARKANSAS NUCLEAR ONE, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 106
License No. DPR-51

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

   A. The application for amendment by Arkansas Power and Light Company (the licensee) dated April 1, 1986, as supplemented August 22, October 14 and October 23, 1986, 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-51 is hereby amended to read as follows:

Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 106, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

John F. Stolz, Director
PWR Project Directorate #6
Division of PWR Licensing-B

Attachment:
Changes to the Technical
Specifications

Date of Issuance: December 5, 1986

ATTACHMENT TO LICENSE AMENDMENT NO. 106

FACILITY OPERATING LICENSE NO. DPR-51

DOCKET NO. 50-313

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
110j	110j
--	110j1
110k	110k
110l	110l
110m	110m
--	110m1
110n	110n
110o	110o
110o1	110o1
110o2	110o2

4.18 STEAM GENERATOR TUBING SURVEILLANCE

Applicability

Applies to the surveillance of tubing of each steam generator.

Objective

To ensure integrity of the steam generator tubing through a defined inservice surveillance program, and to minimize exposure of personnel to radiation during performance of the surveillance program.

Specification

4.18.1 Baseline Inspection

The first steam generator tubing inspection performed according to Specifications 4.18.2 and 4.18.3.a shall be considered as constituting the baseline condition for subsequent inspections.

4.18.2 Examination Methods

a. Inservice inspection of steam generator tubing shall include non-destructive examination by eddy-current testing or other equivalent techniques. The inspection equipment shall provide a sensitivity that will detect defects with a penetration of 20 percent or more of the minimum allowable as-manufactured tube wall thickness except for a sleeved tube at the lower sleeve end.

b. For examination of the sleeved steam generator tubing at the lower sleeve end, the indications will be compared to those obtained during the baseline sleeved tube inspection. Significant deviations between these indications will be considered sufficient evidence to warrant designation as a degraded tube. Direct quantification of the 40 percent through-wall plugging limit is available with eddy-current testing.

4.18.3 Selection and Testing

The steam generator sample size is specified in Table 4.18.1 The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.18.2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.18.4 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.18.5. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in both steam generators; the tubes selected for these inspections shall be selected on a random basis except:

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.

b. 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.

4.18.4 Inspection Intervals

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 consective 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 3.10 (inservice inspection not required if leaks originate from tube-to-tubesheet welds),

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

*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.

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

4. A main steam line or feedwater line break.

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 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 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; it is equal to 40% of the nominal tube wall thickness.

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.

b. The steam generator shall be determined operable after completing the corresponding actions (plug or sleeve all tubes exceeding the plugging limit and all tubes containing 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 45 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; and

c. Identification of tubes plugged and tubes sleeved.

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.

TABLE 4.18-1

MINIMUM NUMBER OF STEAM GENERATORS TO BE INSPECTED DURING INSERVICE INSPECTION

Preservice Inspection	No
No. of Steam Generators per Unit	Two
First Inservice Inspection	Two
Second & Subsequent Inservice Inspection	One[1]

Table Notation:

1 The inservice inspection may be limited to one steam generator on alternating schedule encompassing 3N% of the tubes (where N is the number of steam generators in the plant) if the results of the first or previous inspections indicate that all steam generators are performing in a like manner. Note that under some circumstances, the operating conditions in one or more steam generators may be found to be more severe than those in other steam generators. Under such circumstances the sample sequence shall be modified to inspect the most severe conditions.

TABLE 4.18-2

STEAM GENERATOR TUBE INSPECTION[2,3]

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
A minimum of S Tubes per S.G.[1]	C-1	None	N/A	N/A	N/A	N/A
	C-2	Plug or sleeve defective tubes and inspect additional 2S tubes in this S.G.	C-1	None	N/A	N/A
			C-2	Plug or sleeve defective tubes and inspect additional 4S tubes in this SG	C-1	None
					C-2	Plug or sleeve defective tubes
					C-3	Perform action for C-3 result of first sample
			C-3	Perform action for C-3 result of first sample	N/A	N/A
	C-3	Inspect all tubes in this S. G. plug or sleeve defective tubes and inspect 2S tubes in other S.G.	Other S.G. is C-1	None	N/A	N/A
			Other S.G. is C-2	Perform action for C-2 results of second sample	N/A	N/A
			Other S.G. is C-3	Inspect all tubes in each S.G. and plug or sleeve defective tubes. Request NRC approval of remedial action.	N/A	N/A

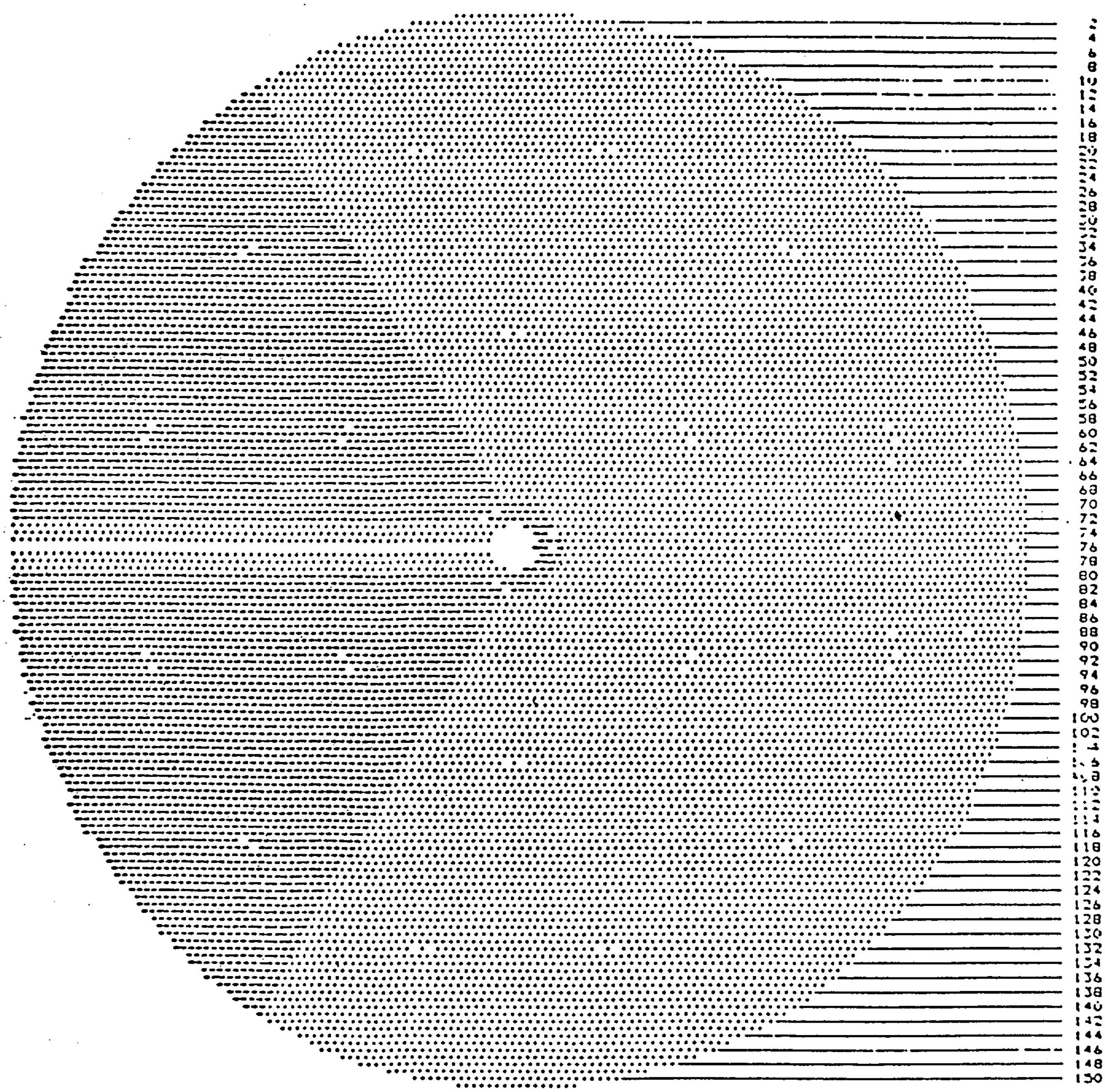
NOTES: [1] $S=3\frac{N}{n}\%$ Where N is the number of steam generators in the unit, and n is the number of steam generators inspected during an inspection.

[2] For tubes inspected pursuant to 4.18.3.a.3: No action is required for C-1 results. For C-2 results in one or both steam generators plug or sleeve defective tubes. For C-3 results in one or both steam generators, plug or sleeve defective tubes and request NRC approval of remedial action.

[3] No more than ten thousand (10,000) sleeves may be installed in both ANO-1 steam generators combined.

FIGURE 4.18.1

Upper Tube Sheet View of Wedge Shaped Group (Group A-3) per Specification 4.18.3.a.3



Description	Tube Count
Group A-1: Lane region tubes as defined in 4.18.3.a.3.(1)	382
Group A-3: Wedge shaped group depicted by darkened region of figure	4880

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 106 TO FACILITY OPERATING LICENSE NO. DPR-51

ARKANSAS POWER AND LIGHT COMPANY

ARKANSAS NUCLEAR ONE, UNIT NO. 1

DOCKET NO. 50-313

1.0 INTRODUCTION

By letter dated April 1, 1986, Arkansas Power and Light Company (AP&L or the licensee) requested amendment to the Technical Specifications (TSs) appended to Facility Operating License No. DPR-51 for Arkansas Nuclear One, Unit No. 1 (ANO-1). Supporting information was provided by letters dated August 22, October 14 and October 23, 1986. The proposed amendment would (1) allow the sleeving of steam generator tubes and (2) modify the designation of those areas identified as special groups in the steam generators where imperfections have been previously found. The licensee plans to conduct steam generator tube sleeving in ANO-1 prior to startup for Cycle 8 operation which is planned for early December 1986.

2.0 BACKGROUND

As a result of degradation in the ANO-1 Once Through Steam Generators (OTSGs), a substantial number of tubes with eddy current indications in excess of the 40% through-wall plugging limit have been removed from service. The suspected mechanism affecting the tubes in the upper tube sheet (UTS) region is intergranular attack (IGA) caused by concentrated chemical contaminants which have been carried by moisture in the steam flowing up through the tube lane region.

The lane region is cooler than the surrounding area due to reduced heat flux and flow resistance. Therefore, more moisture is in the steam in this region. The contaminants carried by this moisture are deposited in the upper tube sheet region. Plugging the tubes in the lane region increases the area of reduced heat flux, thereby increasing the number of tubes affected by moisture in the steam. This aggravates the condition by increasing the amount of contaminants carried by the steam and deposited on the tubes in the UTS region.

To address this problem, AP&L initiated a Steam Generator Integrity Program in 1983. The goal of this program is to identify and initiate changes which will assure that the existing OTSGs can be used for the life of the facility without increased risk to the health and safety of the public or reduction in the unit's performance.

One portion of this program is a Steam Generator Sleeving Qualification

Program which would provide sufficient justification to allow a large-scale sleeving program at ANO-1. The installation of sleeves in the affected tubes should decrease the lane region degradation rate by preventing additional loss of heat transfer area. In addition, the sleeve material has better corrosion resistance than the original tubes. This Qualification Program, which consists of the tests and analyses and development of general design criteria for the Babcock & Wilcox (B&W) OTSG sleeves, is contained in B&W report BAW-1823P, "Once-Through Steam Generator Mechanical Sleeve Qualification." Our evaluation of this report (Reference 2) was completed in November 1984 and included the following areas:

1. Leak-tight integrity
2. Pullout strength of sleeves
3. Joint expansion tests
4. Flow-induced vibration effects
5. Effect of sleeve installation on adjacent sleeves
6. Thermal/hydraulic effects of sleeving
7. Structural and functional integrity of sleeves and compliance with ASME Code requirements

Based on this review, we found the licensee's sleeve/tube qualification program acceptable for a proposed demonstration sleeving of ten tubes at ANO-1. However, additional tests were recommended prior to approval of large scale sleeving. These additional tests were reported by the licensee in the present submittal (Reference 1) and are addressed in this evaluation. The licensee has also included B&W Report BAW-1823P, reviewed earlier as stated above, with the present submittal.

3.0 EVALUATION

3.1 Effect of Corrosion on the Sleeved Joint

Corrosion propagation during normal operation due to increased residual stress and during wet lay-up were investigated on a mechanically sleeved ANO-1 OTSG tube.

To perform this test, a specimen was fabricated from a portion of a tube pulled from the ANO-1 B-OTSG in January 1983 on which IGA was observed. The specimen was fabricated using the process developed for field installation. The specimen was exposed in an autoclave at approximately to an environment that contains the typical feedwater contaminant concentrations. A tensile load of approximately and an internal pressure of about were placed on the expanded joint for the 2000 hour duration of the test. Upon completion of this phase of the test, one of the two expanded joints was removed for metallurgical examination while the other joint was replaced in the autoclave in wet lay-up conditions for 500 hours. This joint was then removed from the autoclave and metallurgically examined with a scanning electron microscope for evidence that the existing IGA had not progressed during the testing.

Examination of test specimens showed that the depth of IGA in specimens removed from the autoclave for operational and wet lay-up simulation was the same as was found in the specimens prior to the test. This test, in conjunction with information previously reported, shows that corrosion propagation is not likely to increase significantly in the rolled joint during normal operation and wet lay-up. Other slower corrosion mechanisms such as corrosion due to cyclic stresses are not likely to be aggravated by the sleeving process. The ten demonstrated sleeves installed earlier will be monitored closely to provide an advance warning of possible corrosion propagation due to unforeseen mechanisms.

Additional data on the effects of roller expanding sleeves inside OTSG tubes affected by intergranular corrosion on the outer surface were obtained by the licensee. The ANO-1 tube samples, each were cut from a previously pulled ANO-1 tube. The samples were obtained from a portion of the tube adjacent to an area known to have IGA present on the outer tube surface.

The inner surfaces of the tube samples were chemically decontaminated to eliminate the need for rolling under hot cell conditions. and the IGA categorized for post rolling comparisons. Upon completion of the tube decontamination, a sleeve was roll expanded into each tube sample to the maximum qualified expansion. The tube samples were examined by eddy current testing (ECT), diameter measurements, metallography and scanning electron microscopy both prior to and after roller expanding a sleeve to characterize the effects of sleeve installation on existing IGA.

The data obtained from this test served as the baseline for comparison to the corrosion test discussed earlier.

In addition to these B&W corrosion tests, Westinghouse also performed tests for AP&L on actual ANO-1 tubing to determine the effects of two different types of sleeving processes. To accomplish this, a detailed characterization of the existing conditions was performed on tubing removed from the ANO-1 OTSGs. The characterization included non-destructive examinations (NDE), analysis of deposits, microexamination and sensitization testing. Sleeving was then performed using both mechanical and braze processes. The mechanical process used by Westinghouse, although not exactly like that used by B&W, is very similar. After each step in the sleeving process, the outer surface of the tube was examined and photographed. From observations, it was determined that the sleeving process did not widen any IGA areas, such as to make them detectable by eddy current, radiography, or visual inspection.

Residual stress measurements, determined by testing, were performed on Westinghouse brazed sleeves and on Westinghouse mechanically expanded sleeves using ANO-1 OTSG tubing. It was verified that the tube residual stresses from roller expansion and brazing process are significantly low and are considered acceptable for a sleeve design.

3.2 Sleeves Installed on Degraded Tubes

The licensee performed tests to determine whether mechanical sleeves installed in the free span of OTSG tubes which have as much as degradations have a reasonable chance of satisfying the qualification program requirements for strength and leak tightness.

These were simplified tests which used OTSG tube specimens which had been machined to to represent tubing with IGA. Two high yield tubes were each sleeved by rolling expansions in the free span and subjecting the assemblies to incremental axial loads while the joint slippage and leakage under internal pressure were measured.

Ultimate failure of the first of the two specimens tested occurred in the thin portion of the tube at This indicates that the sleeve joint is stronger than the tube and both can withstand the maximum axial load of which would result from accident conditions. The second specimen did not fail at an axial load of and was not pulled to failure.

The first specimen had a maximum leakage of at normal operating conditions. Ten thousand of these joints would total less than of the 1.0 gpm Technical Specification limit for unidentified RCS leakage. At accident conditions, the leakage would increase to about of the Technical Specification limit.

The leakage from the second specimen was unusually high at normal operating conditions, decreased and then increased at accident loads. The roll in this specimen was found to be defective and the data from this specimen were disregarded.

3.3 Inspectability and Plugging Limit for Sleeves

Even with the state-of-the-art ECT techniques, the inspection of the rolled transition zones where the sleeve/tube joints are made and the parent tubes at the sleeve's lower end, is difficult. The ability to detect through-wall defects in all regions of the sleeve and parent tube has been demonstrated using existing ECT techniques. The ability to detect through-wall penetrations has been demonstrated for all regions of the sleeve/tube combination with the exception of the tube at the sleeve end. The large signal produced by the inner diameter transition at the end of the sleeve masks the signal for the through-wall tube inspection.

The licensee performed calculations to determine the minimum acceptable wall thickness for degraded sleeves (Reference 3). They have proposed a plugging limit of 40% for both tubes and sleeves. We have reviewed these calculations and find the 40% limit acceptable for all defects with the exception of circumferential cracks. The licensee has agreed to plug all sleeved tubes with circumferential cracks in the sleeve.

The minimum acceptable wall thickness for degraded sleeves was determined in accordance with the allowable stress and pressure limits of ASME Section III and NRC Regulatory Guide 1.121. Primary membrane stress, burst pressure, and fatigue analyses were considered for normal operation, and primary membrane stress, burst pressure, collapse pressure, and primary membrane plus bending stresses were considered for postulated accident conditions. In addition, primary plus thermal stresses were evaluated.

The minimum sleeve wall thickness was calculated for these eight different acceptance criteria. For the expected type of defects, the limiting required minimum wall was found to be 0.0131 inch. This thickness is necessary to resist collapse under the external pressure resulting from a loss of coolant accident (LOCA) and represents 30% of the original Thus, a or greater through-wall defect would require that the sleeve be removed from service. This compared to a defect limit for the OTSG tubes. It is to be noted that allowances for ECT uncertainty and possible tube degradation between inspections have to be incorporated into these values to obtain the plugging limit specified in the Technical Specifications.

The sleeve must be bent and straightened for installation in the outermost OTSG tubes. This results in a slightly elliptical cross section, which was evaluated for buckling pressure. The maximum expected ovality (i.e., difference in extreme ODs at any one cross section) was found to be based on sample dimensions. The critical external pressure depends on the material yield strength. For material with yield strength of the critical external pressure is for the sleeve and for the tube, indicating that the sleeve can sustain about times the external pressure of the tube. Under the maximum secondary pressure of with no primary pressure, neither tube nor sleeve would collapse. In the event water gets trapped between the OTSG sleeve and tube, the sleeve would become more elliptical or distort into a cross section with each successive heatup to accommodate the increased water volume. Continued one-way leakage, although unlikely, would eventually leave the sleeve subject to collapse in the event of a sudden loss of primary pressure such as a LOCA. However, the annular pressure increase is more likely to blow out the corrosion products which plugged the leak than to collapse the sleeve. Thus, the likelihood of sleeve collapse is very small.

The reduced section modulus of the expanded region has only a minor impact (the minimum wall thickness requirement from   for the unexpanded sleeve to   for the roller expanded portion of the sleeve for the accident loads associated with a Main Feedwater Line Break plus Safe Shutdown Earthquake). The analysis shows the minimum wall thicknesses necessary to resist collapse under the external pressure resulting from a LOCA (limiting event) are   for the unexpanded portion of the sleeve and   for the roller expanded portion of the sleeve. Both of these values correspond to a   through-wall defect.

The sleeve wall thickness required to satisfy the primary plus thermal stresses during postulated accident conditions also results in a sleeve wall thickness requirement of about 30% wall thickness for all defects except circumferential cracks. To account for thermal loads, defect limits were based on B&W tensile tests (Reference 4) in which tube specimens with machined defects were pulled to failure by tensile fracture. NRC staff evaluation of this test data indicates that defects including axial cracks   through-wall would satisfy the acceptance criteria.

We are currently evaluating the generic implications of this axial tensile load generated under accident conditions on the various aspects of circumferential cracks and the present 40% plugging limit in the TSs for B&W OTSG tubes. Circumferential cracks at the 15th tube support plate (TSP) region were first observed at Oconee Unit 3 and have since been identified in several other B&W OTSGs. In fact, for many B&W plants, this is often the only predominant type of tube degradation experienced. Although, for ANO-1, circumferential cracks in lane tubes of the upper tube sheet (UTS) and the 15th TSP are not a current problem, the B&W report indicates that even ANO-1 has experienced this type of cracking in the past. B&W has recommended plugging of all tubes with detectable circumferential cracks. We are discussing this issue with the B&W Owners Group and will recommend the necessary changes, if needed, to the ANO-1 tube plugging limit after a generic resolution of this issue is finalized.

3.4 Impact of Sleeving on the ANO-1 FSAR Safety Analyses

The licensee has reviewed the impact on the ANO-1 FSAR safety analyses of sleeving 5,000 tubes per steam generator. The sleeving results in a slight reduction in heat transfer due to the air gap between the sleeve and the steam generator tube. There is also a small increase in the primary side pressure drop through the steam generator due to the smaller tube diameters in the sleeved tubes. Analysis by the licensee has also shown that the effect of installing 5,000 sleeves in each generator would be a reduction in steam superheat temperature of approximately 7.7°F at full power and a reduction in primary flow of less than 1%. This reduction in superheat requires an additional 1% full feedwater flow in order to remove the same amount of primary energy.

For overcooling events, the FSAR analysis assumed that the feedwater flow increased during the event in order to conservatively increase the heat removal by the steam generator. Therefore, sleeving does not impact the safety analysis since the heat removal due to a 1% increase in feedwater flow is conservatively bounded by the heat removal rates assumed in the analysis of overcooling events.

For some overheating events such as the loss of main feedwater, the FSAR analysis assumed that the heat transfer in the steam generator is significantly reduced. The slight reduction in heat transfer coefficient along the sleeved tubes is much smaller than the reduction assumed in the FSAR analysis and, therefore, does not impact the analysis assumptions. Other overheating events which are initiated in the primary system, such as the control rod withdrawal event, are not affected by sleeving since the initial heat transfer rate is held constant throughout the event and overall total steady state steam generator heat transfer is unaffected by tube sleeving.

Previous generic evaluations of the effect of steam generator tube plugging have shown that there is a negligible impact on LOCA results due to a 2.5% reduction in RCS flow. The licensee has indicated that a similar magnitude of tube sleeving would result in only a 1% reduction in RCS flow. Therefore, the generic LOCA analysis accounting for tube plugging conservatively bounds that which accounts for tube sleeving. The licensee has also specifically considered the concern of steam binding in the steam generator affecting the reflood phase of the large break LOCA and has found no impact due to tube sleeving.

Plant procedures require the licensee to measure primary system flow at the beginning of each fuel cycle to verify that the actual flow is in excess of that assumed in the plant safety analyses. These procedures also contain surveillance requirements to monitor primary flow several times per day. Therefore, any flow degradation due to sleeving would be detected to ensure that the existing plant safety analyses remain valid and bounding.

3.5 Conclusions

Review of the additional corrosion tests performed by the licensee shows that corrosion propagation is not likely to increase significantly in the rolled sleeve joint during normal operation and wet lay-up. Other slower corrosion mechanisms such as corrosion due to cyclic stresses are also not likely to be aggravated by the sleeving process. The tube OD residual stresses from the rolled expansion and brazing process are low and are considered acceptable for sleeve design.

The results of the licensee's analysis indicate that the minimum required sleeve wall for normal and accident conditions is inch which permits sleeve defects less than through-wall. The licensee's analysis is in compliance with the requirements of ASME Code Section III and NRC Regulatory Guide 1.121. Allowing an additional margin of 10% for continued degradation and 20% for uncertainty in eddy current measurements, the licensee's proposed 40% plugging limit for sleeves is acceptable. However, the licensee has committed to plug any sleeved tubes with detectable circumferential cracks in the sleeve.

Based on a review of the results of the supplemental corrosion tests, sleeve plugging analyses and the sleeve tube qualification program reviewed earlier, we find sufficient justification to allow a large scale sleeving program at ANO-1.

Based on the above evaluations, the thermal-hydraulic effects of sleeving up to 5,000 ANO-1 steam generator tubes with 80-inch long sleeves per generator will have a minimal and acceptable effect on plant operation, and the existing FSAR safety analyses will continue to bound normal and abnormal plant conditions.

Therefore, on the basis of the above, we have determined that the proposed changes to the ANO-1 TSs are acceptable.

4.0 ENVIRONMENTAL CONSIDERATION

This amendment involves a change in the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. We have 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 this amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, this 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 this amendment.

5.0 CONCLUSION

We have 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, and (2) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Dated: December 5, 1986

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REFERENCES

1. Letter from T. Gene Campbell, AP&L, to J. F. Stolz, NRC, requesting Technical Specification change to allow steam generator tube sleeving, dated April 1, 1986.

2. Letter from John F. Stolz, NRC, transmitting Amendment No. 86 to Facility Operating License No. DPR-51 for Arkansas Nuclear One, Unit 1, to John M. Griffin, AP&L, dated November 3, 1984.

3. B&W Report 32-1147602-02 "177 OTSG Tube/Sleeve Loads," in support of the 40% plugging criteria submitted as attachment to letter from J. Ted Enos, AP&L, to J. F. Stolz, NRC, dated October 14, 1986.

4. Letter from J. Ted Enos, AP&L, to J. F. Stolz, NRC, dated October 23, 1986, including Attachment 1 (Rupture Test Data of Damaged Alloy 600 OTSG Tubing) and Attachment 2 (Collapse Test Data on Damaged Alloy 600 OTSG Tubing).