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

Inservice inspection of steam generator tubing shall include nondestructive 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.

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%), 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.8) 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: deleted

   (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 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 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 3.10 (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. 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.

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

3. Degraded Tube means a tube containing imperfections ≥ 20% of the nominal wall thickness caused by degradation.

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

5. Defect means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective.

6. Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service because it may become unserviceable prior to the next inspection; it is equal to 40% of the nominal tube wall thickness.

7. 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.

8. 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 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.

This report shall be in addition to the report of results of steam generator tube inspections which fall into Category C-3 and which require prompt notification of the NRC per Specification 6.12.3.

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 Inspections	One[1]

Table Notation:

[1] The inservice inspection may be limited to one steam generator on alternating schedule encompassing 3 N % 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 defective tubes and inspect additional 2S tubes in this S.G.	C-1	None	N/A	N/A
			C-2	Plug defective tubes and inspect additional 4S tubes in this SG	C-1	None
					C-2	Plug 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 defective tubes and inspect 2S tubes in other S.G. Prompt notification to NRC pursuant to specification 6.12.3.	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 defective tubes. Prompt notification to NRC pursuant to specification 6.12.3, and request NRC approval of remedial action	N/A	N/A

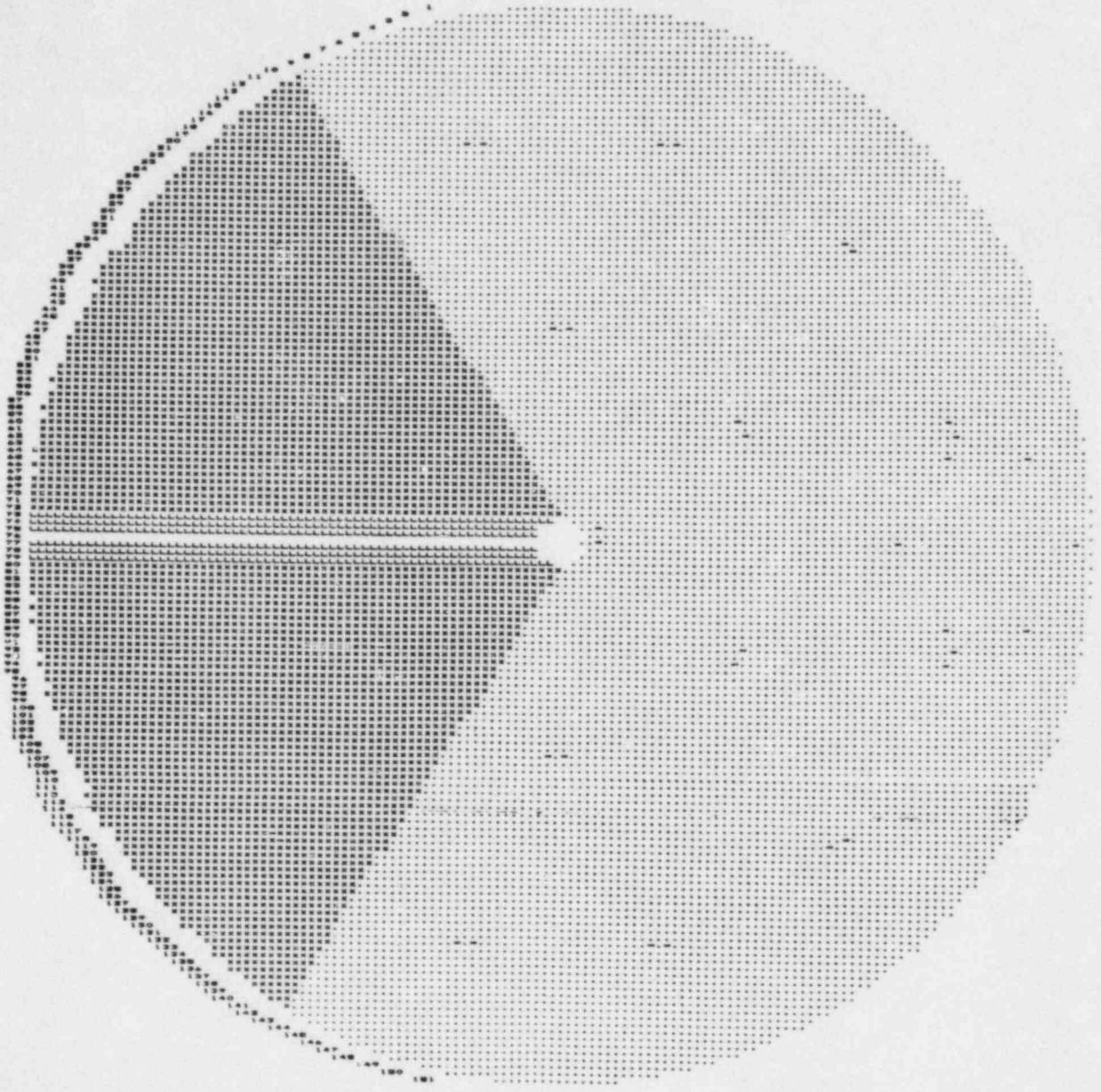
NOTES: [1] $S=3\frac{N}{n}\%$ Where N is the number of steam generators in the unit, and n is the number of steam generators inspected during an inspection.

[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 defective tubes. For C-3 results in one or both steam generators, plug defective tubes and provide prompt notification of NRC pursuant to specification 6.12.3.

[3] As part of a steam generator sleeving qualification program up to 10 demonstration sleeves may be installed in defective tubes in lieu of plugging during the sixth ANO-1 refueling.

FIGURE 4.18.1

Upper Tube Sheet View of Special Groups per Specification 4.18.3.a.3



Plot Character	Description	Tube Count
L	Group A-1: Lane region tube	382
X	Group A-3: Wedge adjacent to lane	4831
-	Support rod location	NA

ATTACHMENT 2

SIGNIFICANT HAZARDS CONSIDERATION (SHC) DETERMINATION

The proposed changes in this Technical Specification change request are to 1) provide clarity, 2) modify the designation of those areas identified as special areas in the steam generators where imperfections have previously been found, and 3) allow the sleeving of ten defective steam generator tubes in lieu of plugging as part of a demonstration program. All of the changes identified are similar to the examples found in the April 6, 1983 Federal Register Vol. 48, No. 67, page 14870, which were considered not likely to involve Significant Hazards Considerations. A thorough discussion of each change and an analysis of it's safety impact, is contained in the following attachments. All of the changes were determined not to involve a SHC because the operation of Arkansas Nuclear One Unit 1 in accordance with these changes would not:

1) Involve a significant increase in the probability or consequences of an accident previously evaluated

2) Introduce the possibility of a previously unanalyzed accident

3) Involve a significant reduction in a margin of safety

Bases

Based on the above, we conclude that this Technical Specification change does not involve a Significant Hazards Consideration.

ATTACHMENT 3

This change request includes the following changes to ANO-1 Technical Specifications 4.18 pertaining to Steam Generator Tubing Surveillance.

a. Technical Specification 4.18.3.a.2: The phrase "except where specific groups are inspected per Specification 4.18.3.a.3" is added to this section to clarify the relationship between this Specification and Specification 4.18.3.a.3. The added statement does not change the intent of the Specification, but rather adds specific wording to make it comply with the Safety Evaluation Report to Technical Specification Amendment #41 which establishes the "potential problem" areas (special groups) of Specification 4.18.3.a.3.

   This proposed change is most like example (i) found in the April 6, 1983 Federal Register Vol. 48, No.67, page 14870.

b. Technical Specification 4.18.3.a.3: Necessary wording is added to permit limiting the inspection of "potential problem" areas to those portions of the tubes (e.g., 15th tube support plate, upper tube sheet face etc.) where imperfections have previously been found. Clarification is also provided to specify that when only a portion of a tube is inspected, the remainder of the tube will be subjected to the random inspection per Technical Specification 4.18.3.

   The existing Specification designates special group of tubes (i.e., areas of the tube bundle) where experience has indicated potential problems exist. These "potential problem" areas were originally identified in Technical Specification Amendment #41. They represent areas where AP&L has acquired enough data from inspections to designate them "critical areas unique to the ANO-1 steam generators." Amendment #41 permitted the option of inspecting 100% of the tubes in the "critical area" in lieu of including these areas in the 1st random inspection.

   Recent inservice inspections at ANO-1 have shown that certain portions of the tubing (i.e., over the tube's height) can also be used to bound "critical areas". Examples of this include the 15th TSP in the existing region A-3 or from the 15th TSP to the upper tubesheet primary face for the lane region (region A-1) and those additional tubes which make up the new A-3 group. The latter groups (the lane and the region adjacent to the lane) has become especially prominent since the 1R5 inservice inspection. Inspection of the tubes in this group below the 15th TSP is unnecessary to detect further degradation due to the intergranular attack mechanism observed at ANO-1. Past inspections at ANO have shown the condition of these tubes to show only normal wear for their age relative to other B&W plant experience. Therefore, AP&L concludes that portions of the tube (from the 15th down) need only be subjected to random inspection. This random inspection is assured by the addition of the last sentence to Specification 4.18.3.a.3.

   Limiting the inspection to that portion of the tubes where previous imperfections have been found is not unique. Current Technical Specification 4.18.3.6 allows the second and third sample inservice inspections to be concentrated on those areas of the tube sheet array

and on those portions of the tubes where previous imperfections have been found.

This proposed change is most like example (iv) found in the April 6, 1983 Federal Register Vol. 48, No.67, page 14870, in that the change represents a refinement to a surveillance requirement based on previously gained knowledge. This change will not, however, increase the probability or consequences of a previously analyzed accident or reduce the margin of safety. The change only provides the option to further define a special group for a detailed inspection which is the intent of Specification 4.18.3.a.3. Only the specific problem area in the generator is subject to a 100% examination, while the remainder of the generator is subjected to the random inspection, which as previously stated, is the intent of Specification 4.18.3.a.3.

c. Technical Specification 4.18.3.a.3.(2): Previous special group A-2 is to be eliminated.

The existing special group A-2 includes tubes having a drilled opening in the 15th TSP. These tubes were included as a special group since tube denting similar to that frequently found in recirculating steam generators was possible in OTSGs. Experience on B&W plants to date has shown that the drilled hole group has not shown any significant tube denting. B&W now recommends only random inspection of the drilled hole group.

Because this special group has not shown significant degradation AP&L does not consider inspection of 100% of the tubes in this group to be necessary in the future. Not inspecting all the tubes in this group would require that these tubes be part of the makeup of the 50% sample required by Specification 4.18.3.a.2. To prevent diluting the 1st sample, elimination of the special group is recommended. This would in turn essentially make the Specification more restrictive.

This proposed change is most like example (iv) found in the April 6, 1983 Federal Register Vol. 48, No.67, page 14870.

d. Technical Specification 4.8.3.a.3(3): A new special group A-3 is added. The new group is defined by a new Figure 4.18.1.

The new special group consists of 4,831 tubes adjacent to group A-1, the lane region. The new group is a large wedge (~1/3 of the tube bundle) originating at the center of the bundle fanning out on either side of the lane region. This new special group is selected due to tube degradation noted in recent steam generator tubing inservice inspections and recent leaker outage tube inspections. Sample analyses performed on tubes pulled during recent inspections have shown that intergranular attack (IGA) is the root cause of tube degradation leading to the plugging of ~280 tubes in the OTSGs. This attack has been concentrated in an around the lane region, group A-1, and at the periphery of the tube bundle near the lane. The proposed group A-2 more than adequately bounds the region of degraded tubing found to date.

Prior to the 11/82 (1R5) outage 26 tubes had been plugged due to service related defects/indications. All 26 tubes were in the A-OTSG (no defects had been recorded in the B-OTSG prior to the 11/82 outage). Twenty two of these defects were located at the upper tubesheet (UTS) secondary face or within the upper tubesheet (UTSM). All twenty two of these defects would have fallen into this new A-3 special group.

The 100% eddy current examination performed during the 11/82 (1R5) refueling outage identified 83 tubes with pluggable defects in the A-OTSG and 45 tubes with pluggable defects in the B-OTSG. The majority of these defects were located in the UTSM (69 tubes with UTSM defects in A-OTSG and 34 tubes with UTSM defects in B-OTSG).

The UTSM defects in both the A&B-OTSG's were located predominantly in a quadrant around the open lane. Defects below the UTS were scattered randomly over the entire tube bundle. Of these defective tubes, 66 in the A-OTSG and 29 in the B-OTSG would have been detected while conducting a special inspection of the new A-3 group from the 15th TSP up. The defects in the remainder of the tubes located within the bounds of the special group (4 in the A-OTSG and 4 in the B-OTSG) were randomly dispersed below the 15th TSP.

The results of the March 1984 mid-cycle outage also supports the proposed configuration of the new A-3 group. During the mid-cycle inspection, an examination identical to that proposed by the new special A-3 group was conducted. The defective and degraded indications identified during this inspection (excluding those tubes with previously reportable indication) all fell well within the bounds of the large wedge defined by Figure 4.18.1. The heaviest concentration of degraded tubes were found within 10 rows of the lane and around the periphery either side of the lane.

The majority of the IGA found to date has been located at and above the secondary face of the upper tube sheet. The inspection of the proposed new A-3 group from the 15th TSP up should provide adequate monitoring of the IGA problem.

Including this large group in the 1st random sample inspection could be expected to lead to a C-3 classification of the ANO-1 generators in the next inservice inspection. This would require 100% inspection of all generator tubing. The special groups were originally added to the Tech Specs to prevent unnecessary 100% inspection of the entire generator. This same rationale is used in proposing the new special A-3 group.

This proposed change is most like example (ii) found in the April 6, 1983 Federal Register Vol. 48, No.67, page 14870. By enacting the provisions of Specification 4.18.3.a.3 with the new A-3 group, 100% of the tubes in the special group must be inspected as opposed to a random inspection of the same tubes if the provision were not enacted. Thus a more thorough examination of these newly identified special group will be performed by its addition as a special group. The inclusion of the new A-3 group will also make the Specification more restrictive, since it will require the inspection of additional tubes to satisfy the requirements of Specification 4.18.3.a

e. Table 4.18-2, Note (2): A typographical error is corrected. Reference to section "4.18.3.a.4" should read "4.18.3.a.3."

This proposed change is most like example (i) found in the April 6, 1983 Federal Register Vol. 48, No.67, page 14870.

f. Table 4.18-2: A new footnote is added to allow for the sleeving of ten defective tubes during the 1R6 refueling as part of a demonstration program.

As a result of degradation in the ANO-1 Once Through Steam Generators (OTSG), a substantial number of defective tubes (tubes with eddy current indications $\geq$40% through-wall) have been plugged. Prior to 1R5 only 26 tubes had been plugged in the A-OTSG (21 defective, 5 preventative) and 3 plugged pre-service in the B-OTSG.

A 100% inspection of both steam generators was performed during the 1R5 refueling outage. As a result, 83 defective tubes were plugged in the A-OTSG (including 1 obstructed), and 45 defective tubes were plugged in B-OTSG (including 3 obstructed).

Since the 1R5 outage the generators have been subjected to two additional inspections, a July 1983 leaker outage in which the A-OTSG was subjected to a limited inspection and a March 1984 mid-cycle inspection during which the tubes making up the wedge shown in proposed Technical Specif-ication Figure 4.18.1 were examined from the 15th TSP up in both generators. As a result of these two inspections 75 tubes were plugged in the A-OTSG and 36 were plugged in the B-OTSG. Therefore, currently there are 196 tubes plugged in the A-OTSG and 88 plugged in the B-OTSG.

Of the defective tubes, approximately 88% have been plugged due to degradation in a limited region: from the mid-span of the upper tubesheet (UTS) crevice down to about 1/2 inch below the lower face of the UTS, at or near the "expanded lane region." (The "expanded lane region" is an area of approximately 1000 tubes located along and at the peripheral end of the partial row of tubes that was omitted for inspection purposes). Also, as the result of the degradation seen during 1R5, two tubes were pulled from the B-OTSG. OD surface intergranular attack (IGA) was found on all examined regions of the two tubes: the lane region tube (B73-8) down to the 15th tube support plate (tsp), and the mid-bundle tube (B112-19) down to the 14th tsp. This IGA was nominally 5-10% through-wall, with one area on B112-19 at 20% through-wall.

Due to the number of defective tubes being identified in the ANO-1 steam generators, AP&L initiated a Steam Generator Integrity Program in 1983. The goal of this program is to identify and initiate changes which will assure the existing steam generators can be used for the life of the facility without reduction in the unit's performance or increased risk to the public's health or safety. One area of this overall program is a Steam Generator Sleeving Qualification Program which would, when completed, provide sufficient justification to allow a large scale sleeving program at ANO-1.

The ability to sleeve defective and potentially defective tubes is important for the following reasons:

A) Carry-over of contaminants up through the open lane region is the suspected mechanism affecting the UTS. Plugging of lane region tubes would aggravate the degradation by additional reductions in heat transfer, thereby spreading the contaminant carry-over to a larger portion of the UTS.

B) Even without spreading, the possibility of additional slow degradation of tubes in the expanded lane region may continue due to existing crevice corrosion conditions that cannot be easily improved.

C) Even though AP&L has evidence that degradation has slowed or stopped, it could be inadvertently reinitiated in the future.

Sleeving should improve each of these conditions by limiting spread of the mechanism by regaining and preventing additional lost heat transfer, and by forming an improved corrosion resistant pressure boundary for the presently affected tubes.

As part of the qualification of the process and materials for steam generator tube sleeving AP&L is proposing in this Technical Specification submittal the implementation of a demonstration sleeving program. A demonstration program is desirable because prior to a full scale sleeving effort the program will:

A) Verify the field installation capabilities before a large scale sleeving is required.

B) Verify and benchmark actual field leakage rates against design criteria and laboratory leakage rates and

C) Confirm the reliability of tube sleeves under actual operating conditions

AP&L intends to contract with Babcock & Wilcox (B&W) for the installation of the ten demonstration sleeves proposed by this Technical Specification change request. In support of this proposed demonstration sleeving program and potential future large scale sleeving operations, B&W has prepared the attached report (Attachment 4)entitled "Once Through Steam Generator Mechanical Sleeving Qualification Program," B&W Report-1823P. The sleeving technique and materials described in this report are those which AP&L plan to use in the installation of the ten demonstration sleeves. This report describes the proposed sleeving methodology, design criteria and qualification testing. B&W has determined that the material in this report is proprietary and therefore, should be withheld from public disclosure per 10CFR2.790. An affidavit in support of this determination is also contained in Attachment 4.

In addition to the qualification program described in B&W Report-1823P and the proposed demonstration sleeving program, several additional

laboratory tests are currently under way which will provide additional support for potential future sleeving programs. These tests are described below.

ANO-1 Specific Corrosion Test

Since the OD of the tubes to be sleeved in the ANO-1 OTSG's could possibly contain intergranular attack (IGA) at the elevation of the free span roll expansion of the sleeve, this corrosion test is proposed to confirm that the expanded sleeve design will not significantly accelerate or propagate the existing IGA in the ANO-1 OTSG.

To perform this test a specimen will be fabricated from a portion of a tube pulled from the ANO-1 B-OTSG in January, 1983, on which IGA was observed. The specimen will be fabricated using the process developed for field sleeve installation. The specimen will be exposed in an autoclave at approximately 600°F in an environment that contains approximately 6 times the typical feedwater contaminant concentrations. A tensile load of 500 lbs. will be placed on the expanded joint for the duration of the 2000 hour test. Upon completion of this exposure, one of the two expanded joints will be removed for metallurgical examination. The remaining joint will be replaced in the autoclave and wet layup conditions at 150°F will be established for a period of one month. This joint will be removed from the autoclave and both joints will be metallurgically examined for evidence that the existing IGA has or has not progressed under the test conditions.

ANO-1 Specific Baseline Roll Examination

B&W, on contract to AP&L, will evaluate the effect of roll expanding a sleeve into existing ANO-1 tubing. Three ANO-1 tube samples, each 7-inches long, will be cut from a previously pulled ANO-1 tube. The sample will be obtained from a portion of the tube adjacent to an area known to have IGA present on the OD surface.

The ID of the samples will be chemically decontaminated to eliminate the need for rolling under hot cell conditions. A small section will then be cut from both ends of the sample and the IGA categorized for post rolling comparisons.

Upon completion of the ID decontamination, a sleeve will be double roll expanded into each tube sample to the maximum qualified expansion. The tube samples will then receive a destructive metallurgical examination consisting of SEM, Stereo macroscopy, and metallography in the roll area to determine if the tube expansion caused any progression of the existing IGA.

Eddy current examination of each tube before and after rolling will be made in order to accumulate data to be compared with the destructive examination data.

40% IGA Screening Test

For this test B&W will fabricate two specimens, each consisting of a portion of an OTSG tube sleeve roll expanded in two places, and whose walls at the joint have been machined to obtain a 40% reduction in the nominal OTSG tube wall thickness. Appropriate test fittings will be attached and an axial load will be applied to the rolled joints. This loading will be increased in 500 lb. increments to joint failure or a value equal to, or in excess of, maximum loads anticipated during normal operation and accident conditions. Water internal to the specimen will be pressurized to a minimum of 1600 psig and leakage through the rolled joints will be measured at each of the axial load increments. This same test will be performed on both test specimens.

The purpose of this test is to verify that the joint has adequate axial strength and leak tightness even under severally degraded conditions. This would also provide confidence that qualification tests of sleeves expanded into laboratory formulated 40% thru-wall IGA degraded tubes would be successful.

To date one specimen has been tested. Although the final report is not available at this time, preliminary reports indicate that the joint survived up to 4535 lbs. at which time the tube itself failed above where the joint was located and where the tube had been machined. A maximum leakage of 5.74 ml/hr was recorded at a load of 3400 lbs. This level of stress is above the maximum expected for a design basis steam line break.

Metallurgical Characterization and Residual Stress Evaluation

The purpose of this test, which Westinghouse will perform, is to examine the effects of two different types of sleeving processes on actual ANO-1 tubing. To accomplish this, a detailed characterization of the existing conditions will be performed on actual tubing removed from the ANO-1 OTSGs. The characterization would include, but not be limited to, NDE, optical and/or SEM, analysis of OD tube deposits, microexamination and sensitization testing. Sleeving will then be performed using both mechanical and braze processes. The mechanical process Westinghouse uses, although not exactly like that which will be performed by B&W, is very similar. After each step in the sleeving process, the OD surface of the tube will be examined and photographed.

The impact of the sleeving processes relative to residual stress levels will be evaluated using stress corrosion cracking susceptibility. Sensitized Inconel Alloy 600 is known to be susceptible to stress corrosion cracking in sulfur bearing environments if tensile stresses are present above a threshold value. The time to initiate cracks is related to the magnitude of the tensile stress increase. Stress corrosion cracking tests will be performed in polythionic acid using stressed C-rings and actual sleeved joints. Residual stress levels in the original tubing as a result of the sleeving operation will be evaluated by comparing time-to-crack for C-rings stressed to known levels with the performance, i.e., time-to-crack, of actual joints. Due to the limited quantity of archive tubing, it will be necessary

that the bulk of the time-to-crack vs. stress level data be generated using a surrogate material. The surrogate material would be sensitized to result in the same level of sensitization as observed in the archive material. This surrogate material would also be employed to develop a stress level vs. time-to-crack curve following a simulated braze cycle.

Following evaluation of the results of the testing described above and the experience gained via the demonstration sleeving program, the extent of additional qualification testing needed to fully support a large scale sleeving program will be determined.

This proposed change is most like example (vi) found in the April 6, 1983 Federal Register Vol. 48, No. 67, page 14870, in that the change is a refinement to the current practice of plugging defective tubes. We do not, however, believe that this change will increase the probability or consequences of a previously analyzed accident or reduce the margin of safety. This change only allows the demonstration sleeving of ten defective steam generator tubes at ANO-1. The method to be used is similar to that which has been employed at other utilities in larger scale projects. The specific sleeving technique to be use at ANO has been thoroughly tested by B&W and shown to be reliable.

ATTACHMENT 4