

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT

SURVEILLANCE INSTRUCTION

1-SI-68-907

STEAM GENERATOR TUBING INSERVICE INSPECTION AND  
AUGMENTED INSPECTIONS

Revision 0

Unit 1

QUALITY RELATED

PREPARED BY: William David James

SPONSORING ORGANIZATION: BOP

APPROVED BY: *Chelms*

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# REVISION LOG

REVISION OR CHANGE NUMBER	EFFECTIVE DATE	AFFECTED PAGE NUMBERS	DESCRIPTION OF REVISION/CHANGE
Rev 0	5/10/96	All	New Instruction formatted to Writers Guide and written to implement technical specification program requirements.

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## 1.0 INTRODUCTION

### 1.1 Purpose

This Instruction provides details and defines the requirements for performing the first 10-year interval Inservice Inspections (ISIs) of Steam Generator (S/G) tubing for WBN Unit 1.<sup>1</sup> The requirements of this Instruction are applicable beginning at the start date of the first 10-year interval of WBN Unit 1. S/G tubing examinations are predominantly performed by contractors. The Steam Generator Tubing Scan Plan is a document defining tubes to be examined in a specified outage and includes examination extent, examination technique (probe), and the eddy-current calibration standard(s) and procedure(s) to be utilized.

The contractor performs the exams as specified and provides the documented examination results. When additional samples are required, the Scan Plan shall be revised and distributed to:

1. Contractor
2. ANI/ANII
3. BOP Tech Support
4. ISO Eddy Current Level III
5. RIMS
6. Corporate Steam Generator Programs
7. Site Nuclear Engineering Responsible Discipline

During implementation phases such as refueling outages, it may become necessary to change the Scan Plan expeditiously. Interim working copies may be hand written to allow examinations to be performed before a formal revision is issued. The interim working copies shall, prior to implementation, obtain the same approval as a Scan Plan revision.

### 1.2 Scope

- A. This Instruction fulfills the 1989 Edition of the ASME Code and exceeds requirements of WBN Technical Specification 5.7.2.12, implementing EPRI guidance to inspect a sample of tubes from each S/G during shutdown.<sup>2</sup> Unscheduled inspections, conducted in accordance with Section 1.3.C.3, shall consider the failure mechanism in determining which S/Gs to be inspected.
- B. Additional augmented inspections administered by the Steam Generator Program on structures of the S/Gs are performed as directed by this Instruction.

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### 1.2.2 Surveillance Requirements Fulfilled and Modes

Performance of this Instruction partially satisfies the following Technical Specifications:

SURVEILLANCE REQUIREMENT	APPLICABLE MODES	PERFORMANCE MODES
p5.7.2.11	1, 2, 3, 4	6
p5.7.2.12	1, 2, 3, 4	6
p5.9.9	All	6

### 1.2.3 Background

Each S/G tube bundle consists of 4,674 NiCrFe alloy (Inconel SB-163) inverted U-tubes of 0.75 inch O.D. by 0.043 inch average wall thickness. During the inspection, S/G tubing shall undergo eddy-current examinations. Other NDE methods may be utilized to improve the characterization of an indication.

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### 1.3 Frequency and Conditions

- A. This Instruction is to be performed at least once every 18 months during a refueling outage.
- B. The first ISI interval is defined by 1-TRI-0-10.
- C. ISIs of S/Gs shall be performed at frequencies indicated in the following paragraphs and in such a manner that the maximum allowable time between eddy-current inspections on individual S/Gs is 72 months.<sup>3</sup>
  1. The first ISI shall be performed after 6 effective-full-power months, but within 24 calendar months of initial criticality on all 4 S/Gs. Subsequent ISIs shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection on at least one at least one S/G.
  2. Additional, unscheduled ISIs shall be performed on each S/G in accordance with the first sample inspection specified in Table 2 of Appendix A during the shutdown subsequent to any of the following conditions:
    - (a) Primary-to-secondary tube leaks (not including leaks originating from tube-to-tube sheet welds) in excess of the limits of Technical Specification 3.4.13, or
    - (b) A seismic occurrence greater than the Operating Basis Earthquake, or
    - (c) A loss-of-coolant accident requiring actuation of the Engineered Safety Features, or
    - (d) A main steam line or feedwater line break.

If an unscheduled ISI is performed for other than above reasons, an engineering evaluation shall determine which S/Gs will be examined.

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## 2.0 REFERENCES

### 2.1 Performance References

- A. MI-68.008, Steam Generator Primary Side Maintenance Activities.
- B. 1-TRI-0-10, ASME Section XI ISI/NDE Program.
- C. MI-3.015, Steam Generator Secondary Side Maintenance Activities.
- D. Steam Generator Tubing Scan Plan.
- E. LAI-1.02, NRC Correspondence.

### 2.2 Developmental References

#### 2.2.1 TVA Procedures

- A. SSP-8.09, Steam Generator Program.

#### 2.2.3 Other

- A. Unit 1 Technical Specifications 3.4.13, 5.7.2.11, 5.7.2.12, and 5.9.9.
- B. Final Safety Analysis Report Section 5.5.2.4.
- C. Regulatory Guide 1.83.
- D. EPRI PWR Steam Generator Examination Guidelines.
- E. ASME Code, Section XI, 1989 Edition.

## 3.0 PRECAUTIONS AND LIMITATIONS

- A. Contractor personnel certifications shall be reviewed and acceptance documented by an ISO ET Level III.
- B. Contractor procedures shall be reviewed and acceptance documented in accordance with SSP-2.03.

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#### 4.0 PREREQUISITE ACTIONS

##### 4.1 Preliminary Actions

**NOTE** The tubes selected for these inspections shall be such that over a five cycle period all tubes are examined.<sup>2</sup> It will be necessary to reconcile performance of this Instruction with the inspection history data base per SSP-8.09.

- [1] **ENSURE** The Scan Plan for S/G tubing examination has been approved by the ISO ET Level III and the Technical Support steam generator program engineer. ☐
- [2] **ENSURE** prerequisite actions of MI-68.008 have been implemented. ☐
- [3] **RECORD** start date and time on Surveillance Task Sheet. ☐
- [4] **INDICATE** the type(s) of performance below:
  - A. Scheduled ISI. ☐
  - B. Unscheduled ISI. ☐
  - C. Augmented ISI (Appendix C). ☐
- [5] **RECORD** start date and time on Surveillance Task Sheet. ☐

##### 4.2 Approvals and Notifications

- [1] **OBTAIN** SOS/Unit SRO approval to perform MI-68.008 and this Instruction on Surveillance Task Sheet. ☐

#### 5.0 ACCEPTANCE CRITERIA

- A. The S/G tube minimum sample size, inspection result classification, and the corresponding Action Required shall, as a minimum, fulfill the requirements in Table 2 of Appendix A. (Refer to Appendix F definitions.)
- B. The S/G 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 2 of Appendix A. (Refer to Appendix F definitions.)



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## 6.0 PERFORMANCE

### 6.1 General

A full-length inspection of a minimum of S (as defined by Table 2 of Appendix A) tubes will be conducted<sup>3</sup>. The hot leg inspection sample and the cold leg inspection sample do not necessarily involve the same tube. Separate entries and selection of different tubes on the hot leg and cold leg sides can meet the minimum sample.<sup>3</sup> Tube inspections shall be selected on a random basis except:

- A. Where experience in similar plants with similar water chemistry indicates critical areas to be inspected, then at least 1/2 S (as defined by Table 2 of Appendix A) of the tubes inspected shall be from these critical areas.
- B. The first sample of tubes selected for each ISI (subsequent to the preservice inspection) of each S/G shall include:
  1. All nonplugged tubes that previously had detectable wall penetrations greater than 20%,
  2. Tubes in those areas where experience has indicated potential problems,
  3. 20% of row 1 and 2 U-bend regions with a RPC (or equivalent) probe qualified to EPRI PWR Examination Guideline, Appendix H, for crack detection,<sup>6</sup>
  4. 20% of the tubes in the region where AVB wear has occurred with bobbin coil (or equivalent) probe,<sup>4</sup>
  5. 20% of the tubes in the outer periphery two rows deep with bobbin coil (or equivalent) probe for the detection of loose part wear,
  6. 20% of Hot Leg top of tubesheet (TTS) Expansion Zone tubes with a RPC (or equivalent) probe qualified for TTS crack detection,<sup>6</sup> and
  7. 20% of dented intersections (greater than 5 volts) in Hot Leg tube support plate (TSP) 1 and 2 intersections with a RPC (or equivalent) probe qualified for dented intersection crack detection.<sup>6</sup>

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#### 6.1 General (Continued)

C. The tubes selected as the second and third sample (if required by Table 2 of Appendix A) during each ISI may be subjected to partial tube inspection provided:

1. The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found, and
2. The inspections include those portions of the tubes where imperfections were previously found.

#### 6.2 Inspection

- [1] ENSURE precautions and limitations in Section 3.0 have been reviewed. \_\_\_\_\_
- [2] ENSURE prerequisite actions in Section 4.0 have been met. \_\_\_\_\_
- [3] PERFORM a tube inspection on each selected tube per MI-68.008. ☐
- [4] IF any selected tube does not permit the passage of the eddy current probe for a tube inspection, THEN  
  
EVALUATE and RECORD the condition in Appendix B, and  
  
SELECT an adjacent tube for inspection. ☐
- [5] IF the initial Hot Leg TTS Expansion Zone Sample detects cracking, THEN  
  
EXPAND RPC (or equivalent) qualified probe sample to 100% of the Hot Leg TTS Expansion Zones in the affected steam generator.<sup>6</sup> ☐
- [6] IF the Expanded Hot Leg TTS Expansion Zone Samples detect cracking in greater than 15% of the Hot Leg TTS Expansion Zones in the affected steam generator, THEN  
  
EXPAND RPC (or equivalent) probe sample to include 20% of the Cold Leg TTS Expansion Zones in all steam generators.<sup>6</sup> ☐
- [7] IF the low row (1&2) U-Bend Sample detects cracking, THEN  
  
EXPAND RPC (or equivalent) qualified probe sample to 100% of low rows (1&2) in the affected steam generator.<sup>6</sup> ☐

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## 6.2 Inspection (Continued)

- [8] IF the Dented Intersection (greater than 5 volts) Sample at Hot Leg TSP 1 and 2 locations detects cracking, THEN

EXPAND RPC (or equivalent) qualified probe sample to 100% of affected intersections in the affected steam generator.<sup>6</sup> ☐

- [9] IF Step [3] C. of Section 4.1 was checked, THEN

PERFORM the appropriate augmented inspection of the S/G in accordance with Appendix C, and

DOCUMENT the results and any followup needed. ☐

## 7.0 POST-PERFORMANCE ACTIVITIES

NOTE Refer to Appendix D definitions to support classification and plugging criteria.

- [1] RECORD S/Gs inspected:

1 ☐ 2 ☐ 3 ☐ 4 ☐

- [2] ENSURE that each S/G tube sample size first sample inspection was greater than or equal to 3N/n% (Acc. Crit.).

- [3] CLASSIFY the results of each S/G sample inspection into one of the three categories identified in Table 1 of Appendix A (Acc. Crit.).

- [4] IF sample results in any S/G are C-2 or C-3, THEN

PERFORM additional S/G tube inspections and plug defective tubes per Appendix A, Table 2 (Acc. Crit.).

- [5] IF results of S/G tube inspection fall into Category C-3, THEN

NOTIFY Operations and Licensing of findings and NRC reporting requirements in accordance with 10CFR50.72 immediately. ☐

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## 7.0 POST-PERFORMANCE ACTIVITIES (Continued)

- NOTE** Appendix B or equivalent shall document the classification of each sample and the quantity of examinations in each sample. Indications from a sample shall be grouped together (i.e., initial sample, first expanded sample, second expanded sample).
- [6] **DOCUMENT** in Appendix B or equivalent the characterization and resolution of all indications of defective tubes and all service-induced wall loss indications. ☐
- [7] **ENSURE** the ISO Eddy Current Level III and S/G Program Engineer have reviewed Appendix B or equivalent and concur with the characterization and resolution of indications. ☐
- [8] **ENSURE** all Appendix A, Table 2 required actions have been completed including plugging all tubes exceeding plugging limit and all tubes containing through wall cracks. (Acc. Crit.) \_\_\_\_\_
- [9] **IF** any S/G tubes required plugging, **THEN**  
**NOTIFY** Licensing of the number of tubes plugged within 5 days of S/G primary manway closure to satisfy Appendix D reporting requirement. ☐
- [10] **RECORD** completion time and date on Surveillance Task Sheet. ☐
- [11] **NOTIFY** SOS/Unit SRO that MI-68.008 and this Instruction are complete. ☐
- [12] **ENSURE** Licensing is notified of inspection findings and reporting requirements in accordance with Appendix D. ☐

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## 8.0 RECORDS

### 8.1 QA Records

The Data Package is a QA record, is handled in accordance with the approved Document Control and Records Management Program, and contains the following:

- A. Surveillance Task Sheet.
- B. Completed parts of Sections 4.0, 6.0, and 7.0.
- C. Section 5.0.
- D. Appendix Data Sheets.
- E. Other sheets added during the performance.

### 8.2 Non-QA Records

None

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INSPECTION SAMPLING/RESULTS/ACTION REQUIRED

CLASSIFICATION OF INSPECTION RESULTS  
TABLE 1

**NOTE** In all inspections, previously degraded tubes must exhibit significant (greater than 10%) further wall penetrations to be included in the percentage calculations below.

INSPECTION 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.

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INSPECTION SAMPLING/RESULTS/ACTION REQUIRED

STEAM GENERATOR TUBE INSPECTION  
TABLE 2

1st SAMPLE INSPECTION			2nd SAMPLE INSPECTION		3rd SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
Minimum of S tubes per S/G	C-1	None	N/A	N/A	N/A	N/A
	C-2	Plug defective tubes and inspect an additional 2S tubes in this S/G.	C-1	None	N/A	N/A
			C-2	Plug defective tubes and inspect an additional 4S tubes in this S/G.	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 each other S/G.  Notification to NRC pursuant to 10CFR50.72.	All other S/Gs C-1	None	N/A	N/A
			Some S/Gs C-2, but no other is C-3	Perform action for C-2 result of second sample.	N/A	N/A
			Additional S/G is C-3	Inspect all tubes in each S/G and plug defective tubes.  Notification to NRC pursuant to 10CFR50.72.	N/A	N/A

S = 3 N/n%

Where N is the number of S/Gs in the unit and n is the number of S/Gs inspected during the inspection period.





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ADDITIONAL AUGMENTED INSPECTIONS

**S/G Primary Bowl Divider Plate Weld Inspection**

A remote visual inspection shall be performed by the S/G Engineer (or his designee) on each S/G once during the 10-year interval. The results shall be documented within the work initiating document for S/G primary-side maintenance.

**S/G Shell Upper Cone Girth Weld Inspection**

A visual inspection shall be performed by the S/G Engineer (or his designee) on each S/G once during the 10-year interval. The results shall be documented within the work initiating document for S/G secondary-side maintenance.

**S/G Feedwater Inlet Inspection**

A remote visual inspection of the preheater inlet modification shall be performed by the S/G Engineer (or his designee) during the first shutdown for eddy-current inspection. Eddy-current tube inspection by bobbin coil (or equivalent) of the preheater inlet area of interest (Cold Leg, Rows 45 through 49, all columns) shall be performed at the first ISI outage. Followup inspection intervals are to be determined based on the results of the above inspections with respect to visual loose parts damage in the preheater inlet assembly and preheater tube wear rate as determined by eddy current during the first ISI.<sup>5</sup>

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REPORTING

Plant management shall report as applicable the following information to the NRC within the time period specified below in accordance with LAI-1.02 reporting instructions:

A. Tube Plugging Report

Following each ISI of S/G tubes, the number of tubes plugged and tubes sleeved in each S/G shall be reported to the NRC within 15 days of S/G primary manway closure per Technical Specification 5.9.9.

B. Inservice Inspection Results Report

The complete results of the S/G tube ISI shall be submitted to the NRC in a special report per Technical Specification 5.9.9 within 12 months following completion of the inspection (S/G primary manway closure). This special report shall include:

1. Number and extent of tubes inspected,
2. Location and percent of wall-thickness penetration for each indication of an imperfection, and
3. Identification of tubes plugged.

C. Category C-3 Report (if required)

Results of S/G tube inspections which fall into Inspection Category C-3 shall be reported to the NRC in accordance with 10CFR50.72. The written followup of this report shall provide a description of investigations conducted to determine the cause of the tube degradation and corrective measures taken to prevent recurrence.

D. Examination Report

1. For-eddy current examination of heat exchanger tubing, the final report supplied by the inspecting vendor or organization shall include a record indicating the tube(s) examined (this may be marked on a tube sheet sketch or drawing), the extent to which each tube was examined, any scanning limitations, the axial location and depth of penetration of each reported degraded tube, and the identification and certification levels of the operator(s) and data evaluator(s) who conducted each examination or part thereof.
2. A summary of the S/G tubing examination shall be submitted to the Site Nuclear Engineering Responsible Discipline for inclusion in the NIS-1, Owners Report for ISI.

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ABBREVIATIONS

- A. ANI - Authorized Nuclear Inspector
- B. ANII - Authorized Nuclear Inservice Inspector
- C. ASME - American Society of Mechanical Engineers
- D. AVB - Anti-Vibration Bar
- E. EPRI - Electric Power Research Institute
- F. ET - Eddy Current
- G. ISI - Inservice Inspection
- H. ISO - TVA's Inservice Inspection Organization
- I. NDE - Nondestructive Examination
- J. NIS-1 - Section XI Code-required report to NRC for ISI.
- K. ODSCC - Outside Diameter Stress Corrosion Cracking
- L. PSI - Preservice Inspection
- M. PWSCC - Primary Water Stress Corrosion Cracking
- N. RPC - Rotating Pancake Coil
- O. S/G - Steam Generator
- P. TSP - Tube Support Plate

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## APPENDIX F

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### DEFINITIONS

1. Degradation - A service-induced cracking, wastage, wear, or general corrosion occurring on either the inside or outside of a tube.
2. Degraded Tube - A tube containing imperfections greater than or equal to 20% of the nominal wall thickness caused by degradation.
3. % Degradation - The percentage of the tube wall thickness affected or removed by degradation.
4. Defect - An imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective.
5. Examination - Denotes the performance of NDE by personnel who are qualified/certified in accordance with SNT-TC-1A.
6. Imperfection - 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.
7. Plugging Limit - The imperfection depth at or beyond which the tube shall be removed from service and is equal to 40% of the nominal tube wall thickness.
8. Preservice Inspection - An inspection of the full length of each tube in each S/G performed by eddy-current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial MODE 1 operation using the equipment and techniques expected to be used during subsequent ISIs.
9. Scan Plan - A schedule of examinations required to be performed during a particular period of time.
10. Tube Inspection - An inspection of the S/G tube from the point of entry (hot leg side) completely around the U-bend to the point of exit (cold leg side) (i.e., tube end to tube end). Entries may be made from either the hot or cold leg sides and separate entries on the hot leg and cold leg sides on different tubes are allowed.<sup>2</sup>
11. Unserviceable - The condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operational Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break accident.

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# SOURCE NOTES

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<u>SOURCE NOTE</u>	<u>SOURCE DOCUMENT</u>	<u>SUMMARY</u>
1	NCO 920032002	Issue a surveillance instruction for S/G tubing inspections.
2	EPRI PWR Steam Generator Examination Guidelines	Conduct a production examination of all S/Gs during scheduled outages. Examine a 20% random sample of each S/G such that all tubes are examined over a five cycle period.
3	NCO 850284005, 850284007 Response to NRC dated 6/17/85, J. A. Domer to NRC	Revise the ISI program to reflect full-length S/G tube inspections.  ISI program shall reflect a maximum 72-month S/G inspection interval for a specific S/G.  Separate entries from the hot and cold leg sides selecting different tubes on the hot and cold leg sides may be used to meet the minimum sampling requirements for inspection.
4	CAQR CHS 89-0044	Adequate examinations during scheduled ISIs shall be performed to detect AVB wear indications.
5	Response to NRC dated 5/27/83, L.M. Mills to NRC, NUREG-0966	Preheater inlet modification ISI program to assess long-term effects of the modification on S/G integrity.
6	Response to NRC Generic Letter 95-03	Inspection plans to detect circumferential cracking of steam generator tubes.