



Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

OCT 05 2001

10 CFR 50.4

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, D.C. 20555

Gentlemen:

In the Matter of ) Docket No. 50-390  
Tennessee Valley Authority )

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - STEAM GENERATOR TUBE  
INSPECTION REPORT

This letter provides the Steam Generator Tube Inspection Report in accordance with the requirements of Technical Specification 5.9.9. The enclosed report addresses the examinations performed during the Cycle 3 refueling outage for WBN Unit 1. Technical Specification 5.9.9 also requires the submittal of a report which identifies the tubes that were plugged based on the inspections performed during the Cycle 3 refueling outage. That report was previously submitted on October 3, 2000.

If you have any questions concerning this matter, please call me at (423) 365-1824.

Sincerely,

P. L. Pace  
Manager, Licensing and Industry Affairs

Enclosure  
cc: See page 2

U.S. Nuclear Regulatory Commission  
Page 2

OCT 05 2001

cc (Enclosures):

NRC Resident Inspector  
Watts Bar Nuclear Plant  
1260 Nuclear Plant Road  
Spring City, Tennessee 37381

Mr. L. Mark Padovan, Senior Project Manager  
U.S. Nuclear Regulatory Commission  
MS 08G9  
One White Flint North  
11555 Rockville Pike  
Rockville, Maryland 20852-2739

U.S. Nuclear Regulatory Commission  
Region II  
Sam Nunn Atlanta Federal Center  
61 Forsyth St., SW, Suite 23T85  
Atlanta, Georgia 30303

**Enclosure**

**Watts Bar Nuclear Plant**

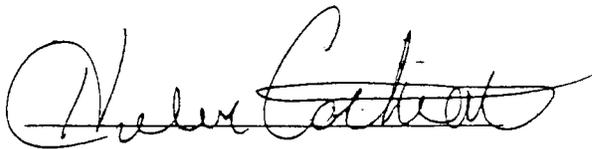
**Unit 1 Cycle 3 Refueling Outage**

**September 2000**

**RESULTS OF STEAM GENERATOR TUBE INSERVICE INSPECTION  
(AS REQUIRED BY TECHNICAL SPECIFICATION SECTION 5.9.9)**

**Watts Bar Nuclear Plant**  
**Unit 1 Cycle 3 Refueling Outage**  
**September 2000**

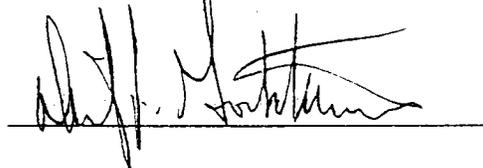
Prepared By:



Verified By:



Approved By:



## TABLE OF CONTENTS

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Glossary of Acronyms .....	3
Introduction .....	4
Steam Generator Tube Inspection Scope .....	5
Steam Generator Inspection Results .....	6
AVB Wear .....	6
ODSCC TTS .....	6
ODSCC TSP .....	7
PWSCC TTS .....	7
Other Plugged Tubes .....	8
Secondary Side Inspection Scope and Results .....	9
Conclusions .....	11

## GLOSSARY OF ACRONYMS

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ARC	Alternate repair criterion
AVB	Anti vibration bar
BOC	Beginning of operating cycle. The current inspection is just prior to BOC-4
EOC	End of operating cycle. The current inspection is at EOC-3
FOSAR	Foreign object search and retrieval
HTS/TTS	Hot leg top of tubesheet
ODSCC	Outside diameter stress corrosion cracking
PWSCC	Primary water stress corrosion cracking
SG	Steam generator
TSP	Tube support plate
PDA	Percent degraded area. This is a measure of average depth of a circumferential crack around the 360° circumference of the tube
UT	Ultrasonic Inspection

## INTRODUCTION

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During the scheduled Watts Bar Nuclear Plant (WBN) Unit 1 End of Cycle 3 (EOC-3) refueling outage, extensive inservice inspections were conducted in all four steam generators (SGs) to address all active and potential damage mechanisms identified in the Unit 1 Degradation Assessment. The results of the inspections were classified as follows:

	<u>SG1</u>	<u>SG2</u>	<u>SG3</u>	<u>SG4</u>
Bobbin	C-1	C-2	C-1	C-1
TTS Plus Point	C-2	C-2	C-2	C-2
Dented TSP	C-1	C-1	C-1	C-1
Freespan Dings	C-1	C-1	C-1	C-1
U-Bend +Point	C-1	C-1	C-1	C-1

Alternate Repair Criteria (ARC) for primary water stress corrosion cracking (PWSCC) inside the tubesheet (F\*) was implemented during this inspection. A letter was issued prior to restart with details of this implementation.

This report fulfills the reporting requirements of WBN Technical Specification section 5.9.9 for reporting results of SG inservice inspection.

## SG TUBE INSERVICE INSPECTION SCOPE

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The WBN SG tube inservice inspection (ISI) initial sample for all SGs and all damage mechanisms was as follows:

100% full-length bobbin examination in all 4 SGs

100% hot leg top of tubesheet (TTS) examination in all 4 SGs with +Point probe.

100% Row 1 and 20% of Row 2 U-Bend examinations in all 4 SGs with magnetic biased ZETEC plus point Row 1&2 U-Bend probe.

100%  $\geq 2$  volt hot leg dented TSP intersections in all 4 SGs with +Point probe.

20% sample of hot leg and 20% sample of cold leg freespan dents from TTS to second hot leg TSP and from FTS to second cold leg TSP

All test techniques used for detection were EPRI Appendix H qualified examination techniques and validated for use at WBN. Sizing techniques were also Appendix H qualified where available. If qualified sizing techniques did not exist, the best available technique was used.

Specifically for the U-Bend data, a sample of Rows 1 and 2 U-Bends at WBN were analyzed for noise prior to the outage and it was determined that the EPRI qualification data did not in all cases bound the plant noise level. However, the EPRI qualification data was collected using non-heat treated tubing, and the heat treating is most likely the cause of the slightly higher noise values. Because of permeability caused by the heat treating, magnetically biased probes are utilized at both plants. The qualified 800 kHz probe is not magnetically biased. The high frequency probe was not utilized at WBN. This is considered safe for the following reasons:

- Row 1 and 2 U-Bends were heat treated prior to startup
- PWSCC has not been detected in the low row U-Bends and is not expected to be identified in this inspection
- WBN just completed its third cycle and there are no signal interferences associated with deposits.
- The tubing is not dented (small number of manufacturing dings)
- Apex is not ovalized due to hour glassing of tube support plate flow slots due to severe denting
- The tubing does not have heavy OD deposits
- Data is clear and not comparable to Indian Point 2

The following changes were implemented:

- All analysts received training on the leaking tube from IP-2 as it appeared in the 1997 examination data
- A circumferential filter was used to assist in flaw detection when bend geometry presented interfering signals.
- Signals that impeded the detection of indications were recommended for preventive repair based on recent industry experience.

## SG TUBE INSPECTION RESULTS

As a result of plugging 29 tubes EOC-3, Unit 1 SGs are 0.4% plugged. Status of each SG is described in Table 1 below:

Table 1

	SG1	SG2	SG3	SG4	Total
Previously Plugged	20	7	2	8	37
Plugged EOC-3	1	13	12	3	29
Total Tubes Plugged	21	20	14	11	66

Main steam line differential pressure is 2560 psi, and three times normal differential pressure is 3855 psi.

### Degradation Mechanisms Detected

#### AVB Wear

Anti-Vibration Bar (AVB) wear was identified in 24 tubes. The limiting indication is 27% maximum depth. Therefore, no tubes were plugged due to AVB wear.

#### Condition Monitoring for AVB Wear

The technical specification plugging limit of 40% maximum depth has been proven to be conservative with respect to structural and leakage integrity at WBN. All indications were well below 40%; therefore, all indications met condition monitoring performance criteria.

#### Circumferential ODSCC TTS

ODSCC at TTS was predicted based on industry experience and WBN's high T-hot and long continuous run. A total of 3 circumferential indications were identified.

All ODSCC TTS indications were plugged on detection and sized using the Plus Point probe and using ultrasonic testing (UT). The UT sizing data was used for structural and leakage integrity analysis since it is qualified for sizing. No indication exceeded structural or leakage screening criteria.

#### Condition Monitoring for Circumferential ODSCC TTS

The three circumferential cracks identified with the Plus Point probe were proven by UT to be small cracks separated by ligaments and non planar. However, structural integrity performance criteria is not exceeded even when the series of cracks are considered in one plane. The sizing below is from UT data and considers all cracks to be in the same plane.

UT sizing was performed using EPRI ETSS #9830, R4, with an RMSE sizing error of 1.02% PDA and 7.54% maximum depth.

SG	Row	Col	PDA	MD
2	34	19	20.97%	49%
4	8	46	7.47%	52%
4	35	36	33.1%	55%

The limiting crack, SG4 R35, C36, when evaluated considering material property uncertainties, burst equation uncertainties, and conservative NDE uncertainties at a 95% probability at 50% confidence, has a calculated burst pressure of 6390 psi. No leakage would be expected even in accident conditions with a maximum depth less than or equal to 55%.

All circumferential ODSCC cracks at the top of the tubesheet meet condition monitoring performance criteria.

#### Axial ODSCC TSP

ODSCC at TSPs was also predicted based on industry experience, WBN's high T-hot, and long continuous run. Two indications were identified in one tube by bobbin (1.07 volts) and confirmed with Plus Point.

ODSCC TSP indications are plugged on detection and sized using the Plus Point probe. The indications detected did not exceed structural or leakage screening criteria.

#### Condition Monitoring for Axial ODSCC TSP

The cracks were in SG2 R13 C51 and measured 0.31", 28% max depth, 15% average depth, and 0.26 volts and 0.15", 58% max depth, 39.7% average depth, and 0.14 volts. The two cracks were parallel and not considered as one crack in the analysis. The calculated burst pressure for the limiting indication is 6407 psi. For axial ODSCC inside TSPs, leakage would not be expected even in accident conditions until at least 3 volts.

Axial ODSCC TSP indications met condition monitoring performance criteria.

#### PWSCC TTS

TTS PWSCC was predicted in the degradation assessment based on WBN and industry experience. A total of 25 axial indications were identified in 19 tubes.

All PWSCC TTS indications were plugged on detection and sized using the Plus Point probe. No indication exceeded structural or leakage screening criteria.

### Condition Monitoring for PWSCC TTS

The limiting indication is SG2 R12 C27. This indication was 0.31" long and had an average depth of 73.03% and a maximum depth of 99% and maximum volts 1.35. This indication was 0.23" above the top of the tubesheet. The calculated burst pressure for this indication is 4179 psi, which is within structural limits.

Based on voltage, leakage would not be expected even in accident conditions. All TTS PWSCC met condition monitoring performance criteria.

### Other Plugged Tubes

If analysts determine that permeability variation or other interfering signals could be masking flaws, tubes are preventively plugged. Three tubes were preventively plugged due to noisy data.

One tube was preventively plugged due to a volumetric indication.

One tube was plugged due to the inability to test past an obstruction at the tubesheet.

One tube was plugged due to loose parts wear. The surrounding tubes were examined with Plus Point and no sign of wear or the part was detected in the surrounding tubes.

## SECONDARY SIDE INSPECTION SCOPE AND RESULTS

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### Cracked Support Plate Indications

Automated analysis of bobbin data was used to detect crack support plate indications, and none were identified. Therefore, design basis function of the support plate has not been lost. There was no evidence of wrapper drop or wrapper degradation.

### Upper Internals Inspection

No upper internals visual inspection was necessary. All four SGs were inspected during the last SG inspection for evidence of erosion/corrosion, cracked welds, deposit buildup, or any other service-induced degradation. No degradation was identified.

### In-Steam Generator Degraded Blowdown Line Assembly Elbows

During the Unit 1 Cycle 1 routine foreign object search and retrieval (FOSAR) inspection of the secondary side of the tubesheet, cracked blowdown elbows were identified in SGs 2 and 3. A safety evaluation was completed and it was determined that the operation of Watts Bar Nuclear Plant Unit 1 with one of two blowdown elbows cracked at the interface between the elbow and elbow-to-tubesheet weld did not pose an unreviewed safety question. It was determined that SG operability was demonstrated and could be demonstrated during future cycles by eddy current inspection of the Row 1 tubes in the vicinity of the elbows and by continued visual inspections of the region.

A special inspection with high resolution cameras and cleaning of blowdown pipe in SG 2 and 3 verified that the blowdown elbows were in the same condition after the third cycle of operation. During this inspection, a crack was identified in SG 1, which had not been identified in previous inspections. The crack was approximately 140 degrees in circumferential extent and located just above the piping-to-tubesheet weld. Improvements in the remote cameras, lighting, and evaluation technique made the crack evident. The other elbow shows no evidence of cracking. The previous outage video was reviewed with enhanced techniques and the crack, which was identified during the last inspection as weld undercut, has not changed. The safety evaluation and operational evaluation performed during the first inspection is bounding. Eddy current examination of 100% of the Row 1 tubes identified no tube degradation. Therefore, safe operation for a full cycle of operation poses no unreviewed safety question.

### Foreign Object Search and Retrieval (FOSAR)

During a mid-cycle outage in the fall of 1996 a small cylindrical object was identified firmly lodged between R1C47 and R1C48 in the hot leg portion of the tube lane in SG 3. Attempts were made to retrieve the object, and it was determined to be unretrievable.

Special tooling was developed for the Unit 1 Cycle 1 FOSAR inspection in order to retrieve the object; however the object again proved to be unretrievable. The object had not moved, and a safety evaluation was performed that concluded full cycle 2 operation at Watts Bar Unit 1 with the object present in the secondary side of the SG did not represent an unreviewed safety question and that tube integrity was expected to be maintained through full cycle.

Attempts were again made during the Unit 1 Cycle 2 FOSAR inspection to retrieve the object. The object remained firmly lodged between R1C47 and R1C48. No tube degradation was identified in R1C47 or R1C48. Attempts were again made during the Unit 1 cycle 3 FOSAR inspection to retrieve the object. The object remains unchanged and no degradation was identified on the surrounding tubes. Since conditions have not changed since the last inspection, the object does not represent an unreviewed safety question and tube integrity is expected to be maintained through full cycle 4 operation.

FOSAR was completed on all 4 SGs and all other identified foreign objects were retrieved.

#### Sludge Lancing

Sludge lancing was performed on all four steam generators: 28 pounds of sludge was removed from SG1, 35 pounds from SG2, 40.5 pounds from SG3, and 30 pounds from SG4. A post-lance inspection confirmed that the top of the tubesheet on all generators was clean.

## CONCLUSIONS

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The NDE testing completed on the WBN Unit 1 SGs and plugging of defective tubes met the Technical Specification and ASME Section XI code requirements for inservice inspection and structural and leakage integrity has been demonstrated; therefore, each SG has been demonstrated operable.

Based on the criteria of 10 CFR 50.59 and utilizing the criteria of Draft Regulatory Guide 1.121, TVA concludes that the integrity of the WBN Unit 1 SGs was maintained during Cycle 3 operation and will be maintained through full Cycle 4 and does not represent an unreviewed safety question.