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

JUN 2 7 1995

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

Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) - NRC GENERIC LETTER (GL) 95-03 - CIRCUMFERENTIAL CRACKING OF STEAM GENERATOR TUBES

This letter provides the 60 day response required by the subject GL for Watts Bar Unit 1. With respect to the requested actions from GL 95-03 TVA has implemented the following:

1. Evaluated recent operating experience with respect to the detection and sizing of circumferential indications to determine the applicability to the plant. This evaluation consisted of evaluating existing WBN data and the operating experience of plants similar to WBN.

2. Developed a safety assessment justifying future operation through the first scheduled steam generator tubing inspection. This safety assessment was developed on the basis of the evaluation in item 1 above, past inspection scope and results, susceptibility to circumferential cracking, threshold of detection, and other relevant factors. Due to a lack of operating history WBN is not able to predict expected or inferred crack growth rates.

3. Developed plans for the next steam generator tube inspections as they pertain to the detection of circumferential cracking.

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The inspection plans address scope (including sample expansion criteria), methods, equipment, and criteria (including personnel training and qualification).

Enclosure 1 to this letter is a safety assessment justifying operation through the first scheduled steam generator tubing inspection. This assessment is based on the evaluations performed in items 1 and 2 above. Enclosure 2 is a summary of the inspection plans developed in accordance with item 3 above and a tentative schedule for the next planned inspection.

If you have any questions, please contact Charles R. Davis at (615) 751-7509.

Sincerely,

Paul Baron

Paul R. Baron
Nuclear Assurance and
Licensing Manager (Acting)

Subscribed to and sworn to before me
this 27th day of June June 1995

E. Jeannette Long
Notary Public
My Commission Expires July 1, 1997

Enclosures
cc (Enclosures):

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
GENERIC LETTER 95-03
CIRCUMFERENTIAL CRACKING OF STEAM GENERATOR TUBES
SAFETY ASSESSMENT JUSTIFYING UNIT 1 OPERATIONS

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
SAFETY ASSESSMENT JUSTIFYING OPERATION OF UNIT 1 THROUGH THE FIRST SCHEDULED STEAM GENERATOR TUBE INSPECTION

1.0 INTRODUCTION

Recent nondestructive examination of the steam generator tubing at the Maine Yankee Nuclear Plant has identified a large number of circumferential indications at the top of the tubesheet region. These most recent inspection findings, coupled with previously documented inspection results regarding circumferential cracking, have led to the issuance of NRC Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes" on April 28, 1995. The information detailed herein will address the requested actions of Generic Letter 95-03 as they pertain to Westinghouse designed and manufactured steam generators in general, and specifically to WBN Unit 1. WBN Unit 1 has not operated, and such should not have active tube corrosion phenomena occurring.

The most recent inspection findings concerning steam generator tube expansion regions (Maine Yankee and Arkansas Nuclear One Unit 2) appear to have impacted those steam generators utilizing the Combustion-Engineering (C-E) EXPLANSION process more than others. While there are similarities between the C-E EXPLANSION process and the Westinghouse WEXTEX process, the degree to which the Westinghouse units, regardless of tube expansion process, have been affected by circumferential cracking is significantly less than the most recent experience of the C-E units. Furthermore, the reported sludge pile height at Maine Yankee may have influenced indication detectability. Such sludge pile thicknesses are not representative of currently operating Westinghouse units.

Successive inspection results using Rotating Pancake Coil (RPC) probes for Westinghouse plants with hardrolled or explosively expanded tubes have indicated steadily declining numbers of new indications, declining angular extent, and, to the degree achievable, very low growth rates. The only occurrences of significant levels of circumferential cracking have been found when plants perform the first large scale RPC inspection.

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WATTS BAR NUCLEAR PLANT (WBN)
SAFETY ASSESSMENT JUSTIFYING OPERATION OF UNIT 1 THROUGH THE FIRST SCHEDULED STEAM GENERATOR TUBE INSPECTION

1.1 Historical Circumferential Degradation Locations

Available historical information shows that for some Westinghouse plants, circumferential corrosion has been detected in the tubesheet region tube expansion transitions from expanded to unexpanded tube, at the Row 1 and 2 U-bend tangent points, and at one plant (two twin units), at dented tube support plate intersections. The main focus of this response will be to address tubesheet region expansion transition cracking since this was the reason for the issuance of the generic letter. Other circumferential crack initiation sites will be addressed in the following section due to their limited numbers of field indications detected and limited number of tubes which can be affected (specifically small radius U-bends and dented tube support plate intersections).

1.2 Circumferential Degradation Evaluation of Small Radius U-bends and Tube Support Plates (TSPs)

The incidence of circumferential indications at the Row 1 and 2 U-bend tangent points has not been significant, both in numbers of indications and indicated RPC angles. Some plants have administratively decided to preventively plug the Row 1 tubes, and in some plants, Rows 1 and 2 tubes. Additional plants have applied U-bend heat treatment (UBHT) in this region and have effectively recovered tubes previously preventively plugged. Westinghouse applied UBHT at WBN Unit 1 in 1986. Field experience has shown the UBHT process to reduce new indication incidence rates at the tangent points. The incidence of circumferential cracking at dented TSP intersections has been limited to one plant which has since replaced steam generators.

A leakage event occurred in 1986 which resulted in a steam generator tube rupture due to high cycle fatigue at a dented top tube support plate. Pursuant to NRC Bulletin 88-02, all domestic Westinghouse steam generators with carbon steel TSPs have been analyzed for the potential to experience high cycle fatigue at this location using a methodology accepted by the NRC. In cases where the analysis indicated that fatigue usage could exceed 1.0, the tube was either plugged and stabilized or plugged using a leak limiting sentinel plug. Three conditions must be present for high cycle fatigue at the top tube support plate, denting, lack of antivibration bar (AVB) support, and locally elevated steam velocities due to nonuniform AVB insertion depths.

In many Westinghouse plants, an augmented top of tubesheet region inspection program is conducted on a cycle to cycle

basis. Many Westinghouse plants have had all hot leg tubes inspected at the top of tubesheet region using the RPC probe and continue to do so on a cycle to cycle basis. Currently available probes coupled with properly implemented calling criteria and techniques have been demonstrated to be and are sufficient to identify circumferential indications in the tubesheet region. Recognizing the potential susceptibility to cracking in the expansion transition regions, many Westinghouse units have implemented shotpeening or rotopeening of the expansion transitions to enhance the resistance of this region to the tube bundle to primary water stress corrosion cracking (PWSCC). This remedial measure, especially when implemented prior to commercial operation, can be effective in mitigating the effects of PWSCC.

Collectively, the items discussed above and further detailed on the following pages provide justification for operation of WBN Unit 1.

2.0 OPERATING EXPERIENCE WITH CIRCUMFERENTIAL CRACKING FOR THE U.S. POPULATION OF WESTINGHOUSE STEAM GENERATORS

This section serves to classify and categorize all Westinghouse steam generators according to tube material and expansion process. Other influencing factors, such as the application of shotpeening or rotopeening will be addressed in Section 3.0.

WBN Unit 1 uses Westinghouse Model D3 steam generators with Full Depth Hardroll Expansion. These steam generators use Alloy 600 Mill-Annealed (MA) tubing. The tubing dimensions for the WBN Unit 1 steam generators are 0.750" outside diameter (OD) x 0.043" nominal wall thickness. The plants using this types of tube expansion technique are listed in the following table.

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TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
SAFETY ASSESSMENT JUSTIFYING OPERATION OF UNIT 1 THROUGH THE FIRST SCHEDULED STEAM GENERATOR TUBE INSPECTION

FULL DEPTH HARDROLL EXPANSION PLANTS
ALLOY 600 MA TUBING

Plant/Steam Generator Model	Startup	First Time Circ. Cracking	Location	Tube Pull and Results
Beaver Valley Unit 2/51M	1987	None	N/A	N/A
Braidwood Unit 1/D4	1987	2/95	Roll Transition	No
Byron Unit 1/D4	1985	9/94	Roll Transition	Yes, circ. ODSCC
Catawba Unit 1/D3	1985	3/91	Roll Transition	Yes, circ. ODSCC
Comanche Peak Unit 1(a)/D4	1990	None	N/A	N/A
Farley Unit 2/51	1981	3/89	Roll Transition	Yes, shallow circ. ODSCC plus axial SCC
McGuire Unit 2/D3	1983	7/93	Roll Transition	No
Shearon Harris/D4	1986	None	N/A	N/A
South Texas Unit 1/E2	1988	2/93	Roll Transition	Yes, circ. plus axial
Watts Bar Unit 1/D3	1995	N/A	N/A	N/A

(a) A total of 14473 tubes in Comanche Peak Unit 1 use full depth roll expansion.

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3.0 WBN Unit 1 Tube Integrity Assessment

The WBN Unit 1 plant is expected to commence commercial operation at full power in the fourth quarter of 1995. The WBN generators have been in wet layup for an extended period of time, and as such would not be expected to have experienced any OD or inside diameter (ID) initiated corrosion phenomena. Additionally, the WBN tube expansion transitions have received tube ID stress conditioning via peening. Since the WBN hot leg tube expansion transitions have been rotopeened and the cold leg tube expansion transitions have been shotpeened prior to operation, the expected benefits of peening can be implied for all tubes. Additionally, UBHT was applied in 1986. These proactive measures should help to reduce the potential for unexpected rapid PWSCC in these regions.

Since the WBN steam generators have not operated, there is no expected active tube corrosion phenomena occurring. It is unlikely that these steam generators would experience any significant degradation phenomena in the first full operating cycle. Operating history indicates that tube ID stress modification has resulted in negligible instances of PWSCC. OD initiated corrosion can be influenced by secondary side bulk water chemistry control. Secondary side water chemistry controls will be implemented during operation of WBN consistent with current industry standards. Additionally, when circumferential degradation began to appear in WEXTEX plants, TVA performed large scale RPC inspections of the top of the tubesheet region in the Sequoyah Units 1 and 2 steam generators. The efficacy of the inspection plans implemented at Sequoyah are evidenced by steadily decreasing numbers of indications and decreasing arc length involvements for successive cycles. The same commitments to superior inspection probes and practices will be applied at WBN, should circumferential degradation begin to occur.

Based on these discussions, it can be concluded that there are no obvious outside influencing factors which could cause a rapid steam generator tube circumferentially oriented degradation phenomena to occur during the initial operating cycle of WBN Unit 1.

4.0 Defense in Depth Positions

The following assessment points further strengthen the WBN steam generator integrity conclusions for the first operating cycle and other future cycles.

1. An administrative primary to secondary leak rate of 150 gpd for WBN Unit 1 has been implemented into plant operating procedures. By reducing the primary to secondary allowable leakage limit below the current Technical Specification value, leak before break margin is inherently provided.

2. The hot and cold leg expansion transitions at WBN Unit 1 have been peened, and as such should have less potential to experience PWSCC. Similarly, since the WBN Unit 1 steam generators have not operated, circumferentially oriented tube degradation would not be expected to be present in the WBN steam generators. Also, dented tube support intersections are not present in the WBN steam generators. UBHT was applied at WBN Unit 1 in 1986. UBHT has been shown to be an effective method of reducing the potential for corrosion in this area.

3. TVA eddy current practices and analysis techniques implemented at Sequoyah Units 1 and 2 have successfully identified circumferential indications. The same commitment to eddy current inspections and analysis will be implemented at WBN Unit 1 as has been implemented at Sequoyah Nuclear Plant.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
GENERIC LETTER 95-03
SUMMARY OF STEAM GENERATOR TUBE INSPECTION PLANS
SCHEDULE FOR THE NEXT PLANNED INSPECTION

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
SUMMARY OF STEAM GENERATOR TUBE INSPECTION PLANS AND A SCHEDULE FOR THE NEXT PLANNED INSPECTION

BACKGROUND

Plant Specific Operating Parameters

WBN Unit 1 is constructed with Westinghouse Model D3 steam generators manufactured in 1975 with 3/4 inch outside diameter by 0.043 wall thickness, low temperature MA (non-thermally treated) Inconel alloy 600 (I-600MA) tubing. Tube expansion into the tubesheet was by the full depth step hard rolling process. Unit 1 is under construction and therefore has "0" Effective Full Power Years (EFPY) of operation. Unit 1 will have approximately 1 EFPY of operation at the first scheduled inspection outage. The operating steam generator primary inlet temperature (T-Hot) is expected to be approximately 618 degrees Farenheit at full power. The secondary side operating chemistry will be All Volatile Treatment (AVT). Plans are to begin secondary side chemistry control during initial power ascension using ethanolamine (ETA) for pH control, hydrazine to scavenge oxygen, boric acid addition to buffer the crevices/prevent Outer Diameter Stress Corrosion Cracking (ODSCC), and ammonium chloride addition as required for molar ratio control.

WBN Areas Susceptible To Circumferential Cracking

The Top-of-Tubesheet (TTS) expansion transition zone is the prevailing tube location in the industry for mainly ODSCC and some PWSCC in Westinghouse Model D plants with full depth hard rolled expansions and I-600MA tubing material. There are a few isolated instances of circumferential indications being reported in Low Row U-Bend locations of I-600MA tubing material for similar plants. WBN has no operating history and therefore denting of tube support plate locations is not a major issue at this time. Preservice inspections have noted a few fabrication related dents at lower TSP locations on the hot leg. WBN Unit 1 has not installed sleeves to date and is therefore not subject to sleeve related circumferential cracking.

WBN Unit 1 Past Inspection Scope And Results

Past preservice inspection scope which would detect circumferential cracking is summarized below. This summary lists steam generator Eddy Current Testing (ECT) including the re-baseline inspection using the latest qualified technology completed in 1993. Samples of tubes determined to be susceptible to circumferential cracking due to tube preservice related geometry anomalies, maintenance, or fabrication influences were examined with RPC. No evidence of circumferential cracking at TTS, dented TSP intersections, or Low Row U-Bends was detected in any sample in any steam generator during preservice inspections.

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WBN UNIT 1 PAST INSPECTION SCOPE

Eddy Current Exams	Rotopeening(1) PMT 03/86	R1&2 U-bend RPC 02/90	Re-Baseline(1) 03/93
TTS RPC	159	-	17
Ubend RPC	-	912	-
Dented TSP RPC(1)	159	-	5

(1) Tube support plate exams included dented and non-dented intersections.

WBN UNIT 1 PAST INSPECTION RESULTS

No circumferential crack indications found in any sample.

Other Relevant Factors

The following ameliorative measures have been completed at WBN Unit 1 to reduce the initiation/propagation of circumferential cracking (ODSCC and PWSCC) at affected locations:

- Hot Leg Rotopeening of the tube inner diameter TTS Expansion Zone.
- Cold Leg Shotpeening of the tube inner diameter TTS Expansion Zone.
- U-Bend Heat Treat Stress Relief of Low Rows 1 & 2 U-Tubes.
- Removal of Copper Alloy Tubing in Feedwater Heaters.
- Tube-to-Tubesheet Roll Expansion Rework to close crevices and correct abnormal roll geometries.
- Preservice Sludge Lancing.
- Added Steam Generator Wet Layup and Recirc Systems
- Added Liquid Nitrogen System for Condensate Storage Tank Sparging and Steam Generator Blanketing.
- Added Steam Generator Blowdown Heat Exchangers.
- Enhanced Steam Generator Blowdown Flow volume and routing.
- Added Condensate Polishers.

Since WBN Unit 1 has not operated, there have been no primary-to-secondary coolant leaker outages, no pulled tubes, and no gross operating or preoperational chemistry excursions.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
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SUMMARY OF STEAM GENERATOR TUBE INSPECTION PLANS AND A SCHEDULE FOR THE NEXT PLANNED INSPECTION

Circumferential Crack Growth Rate

Since WBN Unit 1 has not operated, circumferential crack growth rates have not been determined. The industry obtained circumferential crack growth for like units would be assumed.

SUMMARY OF WBN UNIT 1 INSERVICE INSPECTION PLANS

Inspection Scope

Inservice inspection plans have been developed in accordance with WBN Technical Specifications and the latest revision of the EPRI PWR Steam Generator Examination Guidelines. An example of the typical minimum inspection scope, with respect to detecting circumferential cracking at WBN's first refueling outage based on the current version of the Technical Specifications and EPRI guidelines, is as follows:

Base Scope:

20 percent augmented Hot Leg TTS Expansion Zone sample in each steam generator with RPC or equivalent probe qualified for TTS crack detection.

20 percent augmented Low Row (1 and 2) U-Bend sample in each steam generator with RPC or equivalent probe qualified for U-Bend crack detection.

20 percent augmented dented intersection (greater than or equal to 5 volts by bobbin coil) sample of hot leg TSP 1 and 2 intersections in each steam generator with RPC or equivalent probe qualified for dented intersection crack detection.

Expansion Scope:

IF the augmented Hot Leg TTS Expansion Zone sample detects cracking, then **EXPAND** RPC or equivalent qualified probe sample to 100 percent of the Hot Leg TTS Expansion Zones in affected steam generator.

IF Hot Leg TTS Expansion Zone samples detect widespread cracking in steam generators, then **EXPAND** RPC or equivalent qualified probe sample to include 20 percent of the Cold Leg TTS Expansion Zones in all steam generators.

IF the augmented Low Row (1 and 2) U-Bend sample detects cracking, then **EXPAND** RPC or equivalent qualified probe sample to 100 percent of Low Rows (1 and 2) in affected steam generator.

IF the augmented dented intersection (greater than or equal to 5 volts by bobbin coil) sample at hot leg TSP 1 and 2 locations detects cracking, then **EXPAND** RPC or equivalent qualified probe sample to 100 percent of the affected intersections in affected steam generator.

As a minimum, at each of the above areas, the examination expansion requirements of the technical specifications will be fulfilled.

Inspection Methods

RPC or an equivalent probe qualified to the requirements of EPRI PWR Steam Generator Inspection Guidelines, Appendix H for detection of ODSCC and PWSCC, will be utilized at WBN for detection of circumferential cracking. The use of other supplemental qualified nondestructive examination (NDE) techniques may be used to resolve anomalous/unexpected inservice inspection results.

WBN reviews NDE techniques to:

- Optimize examination methods, minimize noise/interference, and maximize flaw detection.
- Evaluate interfering signals (e.g., lift-off) influence on detection.
- Evaluate examination and analysis procedures to maximize flaw discrimination from unavoidable noise/interference.
- Evaluate examinations for unique unit specific circumstances which necessitate special examination techniques or analysis procedures.

The RPC examination "qualification" requires that a technique demonstrate, at a minimum, a probability of detection (POD) of 80 percent at a 90 percent confidence level for flaws greater than or equal to 60 percent through wall depth on a suitable specimen set as defined by EPRI PWR Steam Generator Examination Guidelines, Appendix H Table S2-2. The actual field performance for qualified techniques is expected to exceed the minimum criteria with the use of conventional RPC for detection of circumferential cracks. This is based on the field data of an industry pulled tube specimen set where the POD is 83 percent at 90 percent confidence level. Only two cracks from the industry pulled tube specimen set were not detected but the maximum depth of those cracks were less than 30 percent through wall.

The EPRI PWR Steam Generator Examination Guidelines provide the direction for developing and applying NDE technology appropriate to manage both existing and emerging damage mechanisms, including circumferential cracking. RPC has been formally qualified per this guideline since 1992 for detection of stress corrosion cracks (irrespective of orientation - axial or circumferential). For circumferentially oriented stress corrosion cracks, field tube pull

data indicates that the performance of RPC exceeds the minimum requirements of the EPRI PWR Steam Generator Examination Guidelines, Appendix H for detection. Industry experience indicates that RPC technology applied in adherence with the above protocol have adequately managed circumferential cracking and is based on available tube pull and in-situ burst testing data which indicates structural limits have not been violated.

Inspection Equipment

WBN will utilize qualified MIZ-30 or TC6700 equipment or equally qualified improved equipment as it becomes available. All equipment will be qualified to EPRI PWR Steam Generator Examination Guidelines, Appendix H.

Inspection Criteria

All eddy current Data Analysts will be certified to Eddy Current Level IIA or III per American Society of Nondestructive Testing SNT-TC-1A and will also be qualified to the EPRI "Qualified Data Analyst" (QDA) program. The site analysis guideline includes the EPRI "Points to Consider in Circumferential Crack Detection and Length Sizing" (memorandum dated February 21, 1995) recommendations. All eddy current analysts are required to complete a site specific performance demonstration and are given a practical exam to demonstrate proficiency and consistency prior to the steam generator inservice inspection. The performance demonstration includes data from similar industry units with damage mechanisms which are expected at WBN in the future. TVA requires independent primary and secondary analyst review of all acquired data with a third independent party resolving any discrepancies from the reviews.

WBN UNIT 1 INSERVICE INSPECTION SCHEDULE

The first planned steam generator inservice inspection will coincide with the first refueling outage at WBN Unit 1, tentatively scheduled for early fall of 1997, Unit 1 Cycle 1 refueling outage.