UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-369/94-05 and 50-370/94-05

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket Nos.: 50-369 and 50-370 License Nos.: NPF-9 and NPF-17

Facility Name: McGuire 1 and 2

Inspection Conducted: January 31-February 1-4, and 7-8, 1994

Inspector: N. Economos 3-7-94
N. Economos Date Signed

Approved by: 3/2/94
J. J. Blake, Chief, Date Signed
Materials and Processes Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This announced inspection was conducted in response to Unit 1 shutdown on January 23, 1994 because of an indicated leak in "D" steam generator (S/G). The leak rate prior to shutdown was approximately 106 gallons per day.

Results:

In the areas inspected, violations or deviations were not identified.

Tube 11-75 in S/G "D" was confirmed as the main source of the primary to secondary leakage indicated on January 23, 1994. The location of the wall crack was confirmed by eddy-current (ET) to be at the upper weld expansion region of the kinetic sleeve weld. The licensee planned to pull this tube for a failure analysis investigation. Twenty-one (21) previously installed roller plugs were to be removed and replaced as correct installation could not be confirmed. Seven hundred twenty-four (724) sleeved tubes were to be plugged as a precautionary measure against the potential of additional leaks in the near future. It is anticipated that the failure mechanism in tube 11-75 was primary water stress corrosion cracking (PWSCC), which was primarily

responsible for the failure of tube 39-72 in S/G "A" in Unit 1, on August 22, 1993.

An extensive revision of the plugging procedure prompted by the loose plug issue at Oconee, caused a protracted delay of the plugging activity and precluded the inspector from observing plug installation and/or tube pulling. The licensee's close overview of contractor Babock & Wilcox Nuclear Technologies (B&WNT's) activities was noteworthy. This overview assured that applicable procedures, equipment, personnel training and required documentation was on site, and in order, prior to work start, and that the work was done safely and correctly.

REPORT DETAILS

1. Persons Contacted

* D. Brenton, Component Engineering (CE), Engineer
T. Cook, Senior Technical Specialist, SGRP
R. Cross, Regulatory Compliance Technical Specialist
C. Freeman, Welding Specialist
*M. Geddie, Station Manager
*L. Kunka, Regulatory Compliance Engineer
D. Mayes, Nuclear Services Engineer, Steam Generators
C. Robinson, Technical Manager, Steam Generator Replacement Project (SGRP)
M. Robinson, Manager, SGRP McGuire Nuclear Station
R. Sharpe, Regulatory Compliance Manager
*M. Thompson, Senior Technical Specialist, CE
*B. Travis, Manager, CE

Other Organizations

Babcock & Wilcox Nuclear Technologies (B&WNT)
W. Carney, Site Night Shift Manager
J. Shires, Contract Manager, Lynchburg
R. Smith, Welding Engineer, Lynchburg
W. Street, Site Representative
J. Zwetolitz, Product Manager Lynchburg
N. Jackson, Site Manager Operations, Lynchburg

Other licensee employees contacted during this inspection included technical support, Quality Assu[illegible]nd administrative personnel.

NRC Resident Inspectors

*G. Maxwell, Senior Resident Inspector
G. Harris, Resident Inspector

*Attended Exit Interview

2. Unscheduled Shutdown Due To Steam Generator Tube Leakage, Unit 1 (IP73753)

On January 23, 1994, Unit 1 experienced an unscheduled shutdown in response to an indicated tube leak in S/G "D", which was calculated to be approximately 106 gallons per day. On January 31, 1994, the inspector arrived on site to ascertain conditions relative to this leakage, to review previous examination records of the tubes found leaking at this time, to monitor examination activities and to observe S/G tube repair activities that would enable the plant to restart.

Through discussions with licensee personnel and review of related records the inspector ascertained that the licensee had confirmed the main source of the indicated leakage was tube 11-75 in S/G "D". Minor leakage was observed in two other tubes. These were tube numbers 10-31 in S/G "D" and 41-86 in S/G "A". In all three tubes, this leakage appeared to emanate from a location immediately above the top of the sleeve. The ID surface of the parent tube above the sleeves appeared to be dry. While under pressure, a steady stream of water was observed coming from tube 11-75. Tube 10-31 weeped at the rate of one drip per five minutes and 41-86 in S/G "A" leaked at the rate of one drip per five seconds. After the close of this inspection the licensee indicated that two sleeved tubes in S/G "B" exhibited slight leakage. The leakage was identified when S/G "B" was pressurized after it was no longer needed to vent the system. The tubes in S/G "B" were identified as 21-20 and 42-36.

Eddy current examination with a bobbin coil probe over the length of tube 11-75 showed no evidence of detectable defects. A followup examination of the kinetic sleeve weld in the subject tube, confirmed the presence of a circumferential, through-wall crack in the parent tube at the upper weld expansion region. The approximate arc length of the crack was estimated as 90 degrees. The three sleeves, in S/Gs "A"& "D" were made of Inconel 690 material. Details relative to the parent tubes and sleeves are as follows:

S/G	Tube Number	Sleeve Install Date	Install Technique	Parent Tube Yield Strength (MTR)	% Carbon Content
"D"	11-75	9/91	Kinetic Weld Top & Bottom	58 KSI	0.03
"D"	10-31	4/90	Kinetic Weld Top Only	55 KSI	0.04
"A"	41-86	4/90	Kinetic Weld Top Only	62 KSI	0.03

For details on methods used to secure these sleeves to the parent tubes see Report 50-369,370/93-19. Through discussions with cognizant licensee personnel and a record review of the previous outage, the inspector ascertained that eddy current examination showed no detectable tube wall degradation or cracking at the tube location found to be leaking.

a. Corrective Actions

(1) Tube Pulls

The licensee decided to pull tube 11-75 for failure analysis and a metallurgical investigation as part of a continuing effort to gain a better understanding of the root cause for these failures. To further help in this process another sleeved tube in S/G "D" was scheduled to be pulled. This tube would be from the group that was sleeved during the outage of April 1990. However, a delay in scheduled work activities, resulted in cancellation of the second tube pull.

(2) Roll Plugs Installed Incorrectly

By memorandum dated February 2, 1994 B&WNT provided the licensee a list of roll plugs installed during the February 1992, McGuire Unit 1 outage. The list included roll plugs for which B&WNT had no QA/QC documentation, video or paper, that would verify correct plug installation. See Oconee Reports 94-01 and 94-04 for details on this issue. B&WNT issued Non Conformance Report #94-00046 to address the problem and recommended that the plugs in question be inspected and rerolled. The licensee took exception to this recommendation and requested that the 21 plugs regarded as questionable be removed and replaced with similar roll plugs made of Inconel 690 material.

(3) Sleeved Tubes Subject to PWSCC

On August 22, 1993 McGuire Unit 1 was shut down in response to an indicated tube leak in S/G "A". The leaking tube was identified as 39-72, which had been previously sleeved and the sleeve had been secured with a double kinetic weld (i.e. top freespan and bottom tubesheet.) A metallurgical investigation by B&WNT determined the leak was caused by circumferential PWSCC in the parent tube at the freespan kinetic weld joint. This investigation also revealed the subject tube exhibited mechanical and metallurgical properties which made it highly susceptible to PWSCC.

In the interm, the licensee developed a susceptibility ranking (SR) system to identify sleeved tubes with mechanical and chemical properties exhibiting a high susceptibility to PWSC. The SR system is intended to predict the life factor for other sleeved tubes relative to the failed sleeved tube, based on certain material properties. This system and results of the investigation on pulled tube 39-72, were presented to NRR on September 29, 1993. As stated earlier, tube 11-75 was sleeved in September of 1991, and according to the SR system it had a predicted life of 9.9 effective full power years.

At this point, the licensee feels that other contributing factors which are not yet fully understood appear to have a significant impact on the service life of these sleeved tubes. Therefore, because it was not practical to restart the plant without first investigating the properties of 11-75 and evaluating what other possible factors were impacting the service life of the sleeved tubes prior to restart, the licensee decided to plug the remaining 724 sleeved tubes in this Unit. The licensee's evaluation of flow through the primary coolant system and volumetric flow through the turbine after the plugging operation, showed that Unit 1, could operate at 100% power with a 1.2% flow margin.

The number of sleeved tubes taken out of service by plugging during this outage included: S/G "A" 262; S/G "B" 152; S/G "C" 77 and S/G "D" 233. The current status of tubes plugged in Unit 1 are as follows:

	S/G "A"	S/G "B"	S/G "C"	S/G "D"
Total Tubes Plugged	691	606	527	719
Percentage of Plugged Tubes	14.8%	12.7%	11.3%	15.4%

The total number of tubes plugged in terms of percentage is equal to 13.6%. By reference, the 10 CFR 50.59 evaluation, performed for Minor Modification, MM-3997, Unit 1 Steam Generator Tube Repair by Plugging, dated February 1, 1994, identified maximum plugging limits for Unit 1 as 18% per steam generator and 15% as the total for all four (4) steam generators. These figures were determined by calculation, DPC 1552.008-0118, LOCA Analysis. (The aforementioned information was provided following the close of this inspection.)

b. Repairs of Steam Generator Tubes

(1) Welding of Plugs

The tube pulling and plugging operations were contracted to B&WNT. In addition, the licensee contracted B&WNT to weld a plug on the hot leg side of the tubesheet in the oversize hole created by the pull of tube 11-75. The cold leg side of the tubesheet will be plugged with a mechanical roll plug. The weld will be made using the remote machine, Inert Gas Tungsten gas (TIG) process. The decision to use the machine automatic process over the manual was a precautionary measure to minimize the risk of running into the kind of problems experienced during the weld repair of tube 39-72 in S/G "A". For details see Report 50-369/93-24.

(2) Installation of Roll Plugs

Steam generator tubes will be plugged with mechanical roll plugs using B&WNT's Delta Roll Tool. This tool has several technological advantages over the Roger Roll Tool, used in previous outages and associated with the loose plug issue at Oconee.

c. Procedure Review

Procedures and other documents relative to this work effort reviewed by the inspector were as follows:

Document	Title
1154835A Rev. 33	Field Procedure for Remote and Manual Rolled Plugging
10 CFR 50.59 Evaluation	NM-3997, Unit 1 Steam Generator Tube Repair by Plugging
10CFR 50.59 Evaluation	NM-3997A, Unit 1 Sleeve Sample removal and Remote Plug Welding of H/C Tubes R-11-C75 and R9-C80 in 1 "D" S/G
DPC-93-150 Rev. 1, NSO-RFK-93-009, Rev. 1 Westinghouse Nuclear Technical Services (W)	Tubesheet Fatigue Effect of Oversize Hole Drilling at McGuire
51-1229198-00	Safety Evaluation of Sleeve Sample Removal (2/94)
1151433A Rev. 20	Tube Pull Field Procedure
51-1229187-00	McGuire Unit 1&2 Kinetic Sleeve Evaluation
NCR 94-00046	Roll Plug/Stabilizer Investigation Summary, B&WNT
02-1210920A Rev. 1	VT-1, Visual Examination of Steam Generator Tube Plug Welds
51-1227940-00	WPS/750/Plug-02 Rev.0
51-1227941-00	PQRs-7050
51-1227942-00	PQRs-7051

Other documents/records reviewed included roll plug material certifications, personnel (welder) performance qualification, consumable certifications, receipt inspection records and DPC's, supplier surveillance records of five surveillances performed between April and October of 1993. By reference, the controlling code(s) for weld procedure qualification was ASME Code Sections IX and XI, 1989 Edition with no Addenda. ASME Code, Section V, 1986 Edition Article 9, would be used for visual examination of the welded plug in S/G "D".

d. Delta Roll Tool Calibration

Within these areas the inspector witnessed a demonstration of the Delta Roll Tool. The tool was first calibrated to a predetermined value as required in the applicable procedure. A roll plug was subsequently expanded until the required torque value was achieved and torque out was indicated. The torque value and roller diameter with respect to time was monitored and displayed on the computer monitor in graph form. The status of the roll was provided on a computer printout and used as a permanent record. The inspector noted that the tool and equipment performed satisfactorily and the results achieved were within the range of established acceptance limits.

e. Work Observation

The loose plug issue at Oconee, prompted an extensive revision of the applicable B&WNT plugging procedure. The revision was still in progress when the unscheduled outage commenced at McGuire and did not become finalized until sometime during February 3, 1994. The licensee's need to review and approve the final version of the procedure, Task Deployment Letter, supplemental work procedures, personnel qualifications and on-site training of B&WNT personnel delayed the start of tube plugging until after the close of this inspection. This precluded any work observation except for the aforementioned demonstration/calibration.

The licensee's component engineering group demonstrated significant strength in the organization, planning and oversight of this repair activity. Daily meetings by key personnel, were used to address and resolve critical issues in a satisfactory manner. Also, they provided direction in work related matters involving safety and plant restart.

3. Steam Generator Replacement Project, Unit (IP 50001)

The inspector met with on-site DPC personnel in charge of the SGR project. The licensee provided a brief update of S/G fabrication, including tube manufacture. Difficulties in meeting specification requirements have been causing delays in S/G tube production. B&WNT International, of Cambridge Canada, is the primary contractor of the

replacement S/G(s). The S/G tubes are being manufactured by Sumitomo Metal Industries of Japan.

The licensee's SGRP corporate and site organizations have been established. A SGRP Manual has been issued which is similar to the Manual issued for Catawba. That Manual was reviewed during a previous inspection documented in Report 413/94-01. The inspector expressed interest in a scheduled visit to B&WNT Lynchburg, VA to observe the qualification of the narrow groove welding procedure. This work effort is discussed elsewhere in this report.

The inspector plans to revisit this area (SGRP), in a future inspection.

4. Qualification of Narrow·Groove Welding Procedure Unit 1, (IP 50001)

On February 7, 1994, the inspector accompanied licensee personnel to the B&WNT facilities in Lynchburg, VA and observed qualification of the Narrow Gap Welding Procedure. This procedure will be used to weld the primary loop piping to the new steam generators at McGuire and Catawba Nuclear Stations.

At the time of this inspection qualification of the welding procedure was in progress. Material used for the qualification consisted of two 36¼ "OD x 2⅝" thick pipe sections, made of SA-351, CF8A type 304, stainless steel. The pipe sections were produced from centrifugally cast material, heat No. 156530. The weld prep was configured to meet open butt, narrow groove weld dimensions provided in B&WNT Specification 51-1221753-00, Narrow Groove Gas Tungsten Arc Welding Procedure Specification (SSNG-GTAW WPS).

Weld filler metal used to produce the weldment was identified as SFA5.9, type ER316L, stainless steel wire, 0.035" diameter, produced from Heat/Lot #XT6396. Power supply was provided from a Gold Track II Diametric machine. Welding was being performed with a single weld head, on pipe fixed in the 6G position, and weld metal deposited in both uphill and downhill progressions. The joint was welded using a single stringer bead, with a single electrode mounted on a specially designed water-cooled weld head. A gas mixture of 70% Helium & 30% Argon was used for shielding, and straight Argon was used for backing/purge.

Procedure Variables such as amperage, arc voltage, wire feed and travel speed were controlled, automatically through previously developed parameters for use during qualification and production. Parameter specifics were considered proprietary and as such are not contained in this report.

The inspector observed the deposition of approximately 12 weld passes and monitored adherence to essential variables. Other areas of interest included weld bead appearance, penetration, weld metal flow, wetting and weld puddle stability during uphill and downhill progressions. Other parameters that were monitored included joint shrinkage, interpass

temperature, travel speed, wire feed, primary and background current and arc voltages. The qualification was performed without the use of optics. The inspector ascertained that optics would be used for welder performance qualifications which will be done on site at McGuire.

The licensee used five welders/operators to monitor the welding of this qualification. All appeared to be knowledgeable, well trained and performed their assigned task in a satisfactory manner. A review of their performance qualification records disclosed that the records were up-to-date and in order.

At the invitation of the licensee, the inspector attended a meeting where both parties discussed pipe cutting, weld joint beveling, and various methods of primary coolant pipe decontamination. Decontamination methods discussed included chemical and electrochemical cleaning, mechanical grit blasting and sponge blasting. In sponge blasting, polyurethane sponge material is mixed with fine particles of an abrasive substance. After evaluating all these different methods, B&WNT decided to use the sponge blast system and is developing the equipment for use at McGuire.

5. Exit Interview

The inspection scope and results were summarized on February 4 and 8, 1994, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the findings. Although reviewed during this inspection, proprietary information is not contained in this report. Dissenting comments were not received from the licensee.