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December 1, 1982

Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Re: Oconee Nuclear Station
Docket No. 50-287

Dear Mr. O'Reilly:

Please find attached Reportable Occurrence Report RO-287/82-12. This report is submitted pursuant to Oconee Nuclear Station Technical Specification 6.6.2.1.a(3), which concerns an abnormal degradation of the reactor coolant pressure boundary. This report describes an incident which is considered to be of no significance with respect to its effect on the health and safety of the public. My letter of October 22, 1982 addressed the previous inability to find the source of this small leak rate.

As noted in the Apparent Cause of Occurrence and Analysis of Occurrence sections of this report, a detailed laboratory analysis is currently underway on the three tubes which were pulled. These sections will be updated when the analysis is complete. The revised report should be submitted by January 17, 1983.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

JFN/php
Attachment

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

Mr. W. T. Orders
NRC Resident Inspector
Oconee Nuclear Station

INPO Records Center
Suite 1500
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Mr. Philip C. Wagner
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Duke Power Company
Oconee Nuclear Station

Report Number: RO-287/82-12

Report Date: December 1, 1982

Occurrence Date: November 17, 1982

Facility: Oconee Unit 3, Seneca, South Carolina

Identification of Occurrence: 3A steam generator tube leaks

Condition Prior to Occurrence: 50% FP

Description of Occurrence:

On October 9, 1982, a steam generator tube leak developed in the 3A steam generator, as indicated by an increase in the 3RIA-40 count level. Based on the radiation count level increase the calculated leak rate was between .02 and .04 gpm, which is well below the steam generator leak maximum allowed for continuous operation of one gpm cited in Technical Specification 3.1.6.2. However, based on previous improved success at Oconee in locating the source of leakage with similarly small leak rates, Unit 3 was shut down on October 10, 1982, and efforts were made to locate and stop the leak. Nitrogen Bubble, Drip, and Eddy Current Tests (ECT) were performed but the leak could not be located. The ECT did indicate one tube with a >40 percent through wall indication (Tube 79-106) and this tube was plugged.

The unit was returned to service on October 22, 1982. The primary to secondary coolant leakage continued with the leakage rate increasing very slowly to 0.5 gpm. On November 17, 1982 the unit was again removed from service for leakage identification and repair. The nitrogen bubble test found five indications of leaking tubes in the 3A steam generator. The locations of the leakers are as follow:

Tube #	Elevation
65-1	Upper Tube Sheet
68-4	15th Tube Support Plate
78-8	15th Tube Support Plate
78-4	15th Tube Support Plate
83-5	15th Tube Support Plate

An extensive Eddy Current inspection of the 3A steam generator was conducted utilizing differential and multicoil Eddy Current techniques. A total of 1851 tubes in 3A were inspected. These inspections revealed a pattern of Eddy Current signal distortions at the 15th Tube Support Plate (TSP) in a wedge shaped pattern from the middle of the triple wide lane region to the periphery. The wedge pattern is centered on the lane region and approximately twenty tubes wide at the periphery. The wedge area contains approximately 400 tubes.

To better characterize the EC signals, a total of three tubes were pulled for detailed analysis. Tube 78-8 was selected since it was one of the leaking

tubes. Tube 78-10 was selected because it had a 15th TSP EC signal distortion but was not indicating any through wall crack. Visual and preliminary lab analysis shows that 78-8 had a partial circumferential crack at the 15th TSP. Preliminary analysis indicates that the cracks appear to have been OD initiated and propagated by low stress high cycle fatigue. This is the "standard" pattern which has been exhibited by other leaking "lane" tubes in B&W Once Through Steam Generators. Examination of 78-10 has found a slight restriction of the tube at the 15th TSP but no evidence of a wall reduction or through wall defect.

Additionally, these two tubes were Eddy Current inspected before and after pulling to fully characterize the Eddy Current signals and to refine the capability to detect tube faults in the distorted signal. Using this refined technique the wedge pattern was reinspected to locate all remaining tube faults. Additionally, tube 79-5 whose ECT indicated a non-through-wall crack was pulled to try to determine the initiating mechanism.

After pulling tubes 78-8 and 78-10, fiber optic visual inspections were made through the 78-8 hole of the 15th Tube Support Plate broached holes and adjacent tubes. The inspection findings were consistent with previous visual inspections of the periphery tubes, Upper Tube Sheet (UTS) and 15th TSP after the recent internal auxiliary feedwater header repairs. These inspections showed deposits on the tubes and "flow patterns" on the UTS in the same wedge pattern as indicated by the ECT. Additionally, magnatite type deposits were noted on the 15th TSP but the broached holes were not blocked.

Apparent Cause of Occurrence:

The apparent cause of the tube leaks was circumferential cracking propagated by low stress high cycle fatigue. This is similar to previous failures in the lane region at the 15th Tube Support Plate. Detailed lab analysis is currently underway on the three tubes which were pulled to try to determine the exact initiating mechanism. However, from the preliminary lab analysis, the Eddy Current Tests and the visual inspections, the problem seems to be limited to a wedge shaped pattern around the lane region of the 3A generator only. The failures are believed to have been brought on by the extended period of time that the 15th TSP was out of wet lay-up due to the internal auxiliary feedwater header repairs and the unique 3A tube lane.

In B&W designed Once Through Steam Generators (OTSG) the first 63 tubes were left out of row 76 (Z axis) to form an inspection lane. Unique to Oconee 3A OTSG, tubes 75-10 through 75-46 and tubes 77-11 through 77-47 were omitted due to an error in manufacturing the OTSG. This results in a unique triple wide open lane in the middle area of the lane. During unit operation this would tend to act as a "chimney" for high velocity lower quality steam. This triple wide flow would be forced to exit the steam generator through the single lane periphery opening. Thus, the flow would fan out on either side of the lane as it exits the bundle to the lower pressure steam annulus. This flow pattern is consistent with the extensive visual and Eddy Current inspection findings.

Also unique to Oconee 3A was the extensive repairs required on the internal

auxiliary feedwater header located between the Upper Tube Sheet and the 15th Tube Support Plate. The extensive inspection and repairs, while not directly damaging the steam generator tubes, resulted in the 15th TSP being out of wet lay-up for a period of approximately five months. This appears to have allowed some corrosion of the 15th TSP.

The unique 3A lane area flow pattern with its resulting vibration and deposits coupled with the extensive period of time in which the 15th TSP was out of wet lay-up appears to have degraded some tubes in a well defined wedge shaped pattern around the Z axis lane. The failure mechanism itself appears similar to previous leaking tubes in the lane region of other OTSGs.

Analysis of Occurrence:

Extensive Eddy Current Inspections were conducted in the Oconee 3 steam generator in June prior to the auxiliary feedwater header repairs, and again prior to unit restart in October. The inspections of Unit 3A OTSG at those times revealed Eddy Current signal distortions of a wedge shaped pattern of tubes at the 15th Tube Support Plate center on the open lane. Eddy Current Tests (ECT) during the current outage revealed cracks in the identified leaking tubes in the 15th Tube Support Plate ECT signal distortions. Multicoil and differential ECT of the pulled tubes helped refine the capability to distinguish even minute cracks in the tubes whose signal may have been previously hidden in the ECT 15th TSP signal distortions of this wedge of tubes. A conservative inspection which encompassed 100 percent of the wedge area using the refined techniques identified several additional tubes which will be removed from service. There is good confidence in the ability of the inspection technique and personnel to detect even minute cracks in the tubes now.

The leakage of the tubes during operation was 0.5 gpm which is half of the technical specification allowed limit of 1 gpm. Personnel and systems adequately controlled this event and the releases were well within regulatory requirements. Thus, it is considered that the health and safety of the public were not affected by this event.

Corrective Action:

The reactor was shut down and five leaking tubes were identified. Extensive Eddy Current and visual inspections were performed on the 3A steam generator to define the problem. The area of concern was narrowed to a wedge shaped pattern centered on the open lane of the 3A steam generator. A total of eleven tubes were removed from service (including three which were pulled for laboratory analysis).

The 3B steam generator was leak tested and Eddy Current Tested to ensure that a similar problem does not exist in that steam generator. A total of 432 tubes were inspected with no pluggable indications. The 3B steam generator has a standard single tube wide inspection lane and was in wet lay-up during the time of recent extensive repairs to the 3A internal auxiliary feedwater header.

A detailed laboratory analysis is underway on the three tubes pulled from the 3A steam generator. The results of this analysis will be utilized to determine if any additional long term corrective action is required. Solutions to the OTSG lane flow problems are being aggressively pursued by Duke Power in conjunction with the B&W Owners Group Steam Generator Integrity Subcommittee.