U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-336/89-20

Docket No. 50-336

License No. DPR-65

Licensee: Northeast Nuclear Energy Company
P.O. Box 270
Hartford, Connecticut 06141-0270

Facility Name: Millstone Unit 2

Inspection At: Waterford, Connecticut

Inspection Dates: November 7 - 9, 1989

Inspector: R. W. Winters, Reactor Engineer, MPS, EB, DRS, Region I — 12/20/89 date

Approved by: J. Strosnider, Chief, Materials & Processes Section, Engineering Branch, DRS, Region I — 12/20/89 date

Inspection Summary: A routine announced inspection was conducted from November 7-9, 1989 (Report No. 50-336/89-20) of the mid-cycle steam generator tubing eddy current examination.

Results: No violations or deviations were identified. The licensee performed a thorough inspection of the steam generators. The inspection results indicated that the mid-cycle inspection was a prudent action to assure safe, reliable operation of the steam generators.

DETAILS

1.0 Persons Contacted

* J. Benson, Corporate Engineering, Level III, ECT
* T. Blanchard, Jr., Inservice Inspection Coordinator
* J. Keenan, Superintendent, Unit 2

Combustion Engineering

R. Maurer, Supervisor, Eddy Current Data Analysis

Zetec Corporation

S. Alspaugh, Supervisor, Eddy Current Data Analysis

United States Nuclear Regulatory Commission

* C. Dodd, Consultant, Oak Ridge National Laboratory
* P. Habighorst, Resident Inspector, Unit 2
* W. Raymond, Senior Resident Inspector

* Denotes those attending the exit meeting.

The inspectors also contacted other administrative and technical personnel during the inspection.

2.0 Introduction

In 1987 a leak from a circumferential crack at the top of the tube sheet forced a shut down of the plant. Circumferential cracking was detected at the top of the tube sheet using a combination of differential bobbin and rotating pancake coil inspections. The cracking initiated from the secondary side and was caused by intergranular stress corrosion. This cracking occurs in both the hot and cold legs of the steam generators in a region that contains the sludge pile. At the refueling outage in February 1989, 309 tubes with circumferential cracks were detected. Due to this large number of cracks, the licensee agreed to shut down to perform an inspection before the next refueling outage.

3.0 Steam Generator Inspection

Background

The motorized rotating pancake coil (RPC) has been successful in detecting some circumferential cracks. The licensee attempted to develop a more sensitive and faster probe for detecting these cracks. This probe is the Transmit Receive Probe (TRP). The TRP consists of 16 pancake coils arranged in two rings around the circumference of the probe. The pancake probes are fixed on the outer surface of a nonconducting form, and covered with a thin (0.006 inch thick) stainless steel sheath. The assembly has an outer

diameter of 0.600 inches. This arrangement gives a nominal lift off between the pancake coils and the Inconel tube of approximately 0.035 inches which is considerable more than normal for a pancake coil. A set of stiff centering disk on the probe are designed to reduce variations in lift off or probe wobble. A narrow grove bobbin coil was placed on the probe to provide position information.

The send and receive coils are interspersed and connected so that the received signal is zero when there is no defect in the tube. This arrangement also provides a zero signal from artifacts that have complete axial symmetry such as the tube sheet and tube supports. However, since the probe is sensitive to small deviations from symmetry either in depth or displacement it is unlikely that the required degree of symmetry for signal cancellation would be found in any defect. The licensee planned to use the TRP for screening to determine if there might be a defect present. Then the RPC was to be used for evaluation of suspected defects.

Testing

During the testing of the steam generators it was determined that the TRP did not work as the licensee had anticipated due to interference from magnitite and copper deposit signals. The use of the TRP was abandoned during the examination of the steam generators for this reason and the RPC was used instead for all testing.

The sensitivity of the RPC to detect small defects was improved since the February inspection by optimizing the frequency mix for detection. This was done at the expense of sizing accuracy. However, once located the frequency mix was adjusted to determine defect size. The signal to noise ratio was increased by using a larger probe motor to give a more constant probe rotation.

The licensee's inspection plan tested an equal number of tubes using the RPC for crack detection and a bobbin coil for pitting. This plan included provisions to expand the scope until no defects were found within three tubes of the edge of the inspected region. As a result the RPC inspected was expanded since three cracks were found in this region. The bobbin coil testing was not expanded. In addition ultrasonic testing was performed on all tubes that had indications of cracking.

Results

The inspectors reviewed data tapes from the RPC scans of the three tubes that were removed from the steam generator. Each of these data tapes was compared to the February 1989 data. The data from tube 14-118, steam generator 2, from the February inspection did not show any defect. However, the October 1989 data from this tube indicates a crack extending about 350° around the tube. This defect only shows on one rotation around the tube, which is not normal for the scan rate used and the effective width of the coil used. This indicates that the coil experienced an anomaly that either caused an abrupt change in pulling speed or that something,

such as a copper deposit, masked the defect. An ultrasonic test confirmed that there was a defect present but subsequent eddy current scans failed to locate this defect. This section of the tube was removed and will be metallurgically analyzed to determine the cause of this difference between eddy current and ultrasonic testing.

The inspectors also reviewed the data from steam generator 1, tube 22-52. This tube had not shown any defects in February but in the October inspection a crack was estimated to extend 180° around the tube.

The data from tube 29-145 in steam generator 1 was reviewed. In this case the crack appeared to be barely detectable using the improved frequency mix first used in October. Using this mix on the February data indicated that the signal was almost identical for the two inspections.

At the time of this NRC inspection metallurgical examinations of these tubes (22-52, 29-149 from SG 1, 14-118 from SG 2) had not been completed.

The extent and results of the mid-cycle eddy current examination of the steam generators in shown in Table 1.

TABLE 1

SCOPE AND RESULTS OF THE EDDY CURRENT EXAMINATINS

SG No.	Leg	RPC Scope	Cracks	Severe Cracks	Bobbin Scope	Pits	Other Defects	Total Plugs
1	Hot	2793	58	13	2409	55	8	
1	Cold	1447	36	12	1353	19	2	169
2	Hot	2300	3	2	2264	5	0	
2	Cold	1359	7	2	1359	32	1	47

Notes:
Severe cracks are greater than 200° in circumference
Some tubes contained more than one defect

Conclusions

The licensee's efforts to improve the quality of eddy current inspection through the use of the Transmit/Receive Probe, although unsuccessful, were indicative of an aggressive approach to providing better data during the inspection. The use of frequency mixes more sensitive to finding cracks also indicate the desire to determine the existing problems with the steam generator tubes.

4.0 Management Meetings

Licensee management was informed of the scope and purpose of the inspection by the resident inspector before the start of the inspection. The findings of the inspection were discussed with licensee representatives during the course of the inspection and presented to licensee management at the November 9, 1989 exit interview (see paragraph 1 for attendees).

At no time during the inspection was written material provided to the licensee by the inspector. The licensee did not indicate that proprietary information was involved within the scope of this inspection.