U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-289/88-20

Docket No. 50-289

License No. DPR-50

Licensee: GPU Nuclear Corporation
Post Office Box 480
Middletown, Pennsylvania 17057

Facility Name: Three Mile Island Nuclear Generating Station - Unit 1

Inspection At: Middletown, Pennsylvania

Inspection Dates: July 25 - 29, 1988

Inspector: Jack Strosnider for R. W. Winters, Reactor Engineer, MPS, EB, DRS, Region I — 8/12/88 date

Approved by: Jack Strosnider J. Strosnider, Chief, Materials & Processes Section, Engineering Branch, DRS, RI — 8/12/88 date

Inspection Summary: Routine unannounced inspection on July 25-29, 1988 (Report No. 50-289/88-20)

Areas Inspected: The inspection covered steam generator eddy current inspection results, secondary side water chemistry, radiation exposures resulting from the eddy current inspection and repairs of the steam generators.

Results: The inspector concluded, based on the areas inspected, that the licensee's activities were performed in compliance with the applicable requirements of the Technical Specifications and the ASME Code, Section XI. No violations or deviations were identified.

DETAILS

1.0 Persons Contacted

* R. Barley, Three Mile Island Unit 1, Engineering Manager
  K. Behling, Radiation Control Engineer
* E. Fuhrer, Chemistry Manager
* J. Jandovitz, Inservice Inspection Supervisor
* S. Otto, Licensing Engineer
  J. Schmidt, Radiation Control Engineer
  R. Shaw, Radiation Engineering Manager
* M. Torborg, Inservice Inspection Engineer
  M. Zeise, Quality Control Outage Coordinator

United States Nuclear Regulatory Commission

T. Moslak, Resident Inspector, Three Mile Island Unit 1

* Denotes those attending the exit meeting.

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

2.0 Introduction

Three Mile Island Nuclear Generating Station Unit 1 is a Babcock and Wilcox designed pressurized water reactor unit. It was licensed for operation April 19, 1974 and went into commercial operation September 2, 1974. The two vertical once through steam generators (OTSG) were designed with 15,531 Inconel tubes having a 0.625 inch outside diameter and a nominal wall thickness of 0.034 inches. The heating length of these tubes is 52 feet 1 3/8 inches giving a total heating area of 132,436 square feet. There are fifteen tube support plates between the upper and lower tubesheets to stabilize the tube bundle. These plates have broached tri-lobed holes except at the outer diameter to allow upward flow during operation. The outer diameter holes are drilled. Tube support spacers position and stabilize the tube support plates at various elevations in the tube bundle. Full load design temperature is $603^{\circ}F$ at 925 psia for the primary side. The units are designed for a steam flow of $5.301X10^{6}$ pounds per hour.

Prior to the 1988 eddy current inspection the 'A' and 'B' generators had 1247 and 359 tubes, respectively, out of service. Subsequent to the 1988 eddy current inspection the 'A' generator had 262 degraded tubes of which 19 had defects that grew more than 10%. The 'B' generator had 26 degraded tubes of which 5 had defects that grew more than 10%.

3.0 References/Requirements

Technical Specifications, paragraph 4.19 OTSG Tube Inservice Inspection

Procedure 1300-4B, Revision 3, Eddy Current Examination of OTSG

Procedure 1030, Revision 11, Control of Access to Primary and Secondary System Openings

Procedure 1020, Revision 10, Cleanliness Requirements

4.0 Steam Generator Eddy Current Inspection

Scope

The results of the eddy current inspection of the OTSGs completed in July 1988 were reviewed and the methods of data collection and analysis was discussed with licensee personnel. Improvements made in the testing techniques to provide better inspection with less radiation exposure were also discussed.

Details of the Review

The inspector reviewed the data from the July 1988 eddy current inspection and interviewed personnel concerning the past inspection. During this inspection 3% of the tubes in each OTSG were eddy current inspected and the results showed the OTSGs to be in Technical Specification category C2. As a result an additional 6% of the tubes in each OTSG were inspected and the result placed both OTSGs in category C1.

Testing was performed using a standard bobbin probe approximately 0.015 inch diameter less than the nominal tube diameter. When indications of defects were identified a verification inspection was made using an 8X1 pancake probe to further define the defect.

The inspector verified that the correct tubes were plugged by reviewing the videotapes of the tube marking and plugging verification operations for the 'B' OTSG.

The inspector discussed the methods used during the eddy current inspection with licensee personnel. One improvement the licensee had made during this inspection was achieved by slowing the speed the probes were inserted into the tubes. In the past the maximum rate of insertion was used to reduce the dead time since the actual test is performed as the probe is withdrawn. Because of the clearance between the probe and the tube wall is approximately 0.015 total, any obstructions tended to cause the probe to jam during insertion. Such jamming would result in the licensee (or eddy current contractor) having a difficult time removing the jammed probe since reversing the

probe drive would often not pull the probe out thereby increasing inspection time and radiation exposure. By reducing the insertion speed the probes that jammed with one exception were able to be removed with the insertion drive. A further improvement that reduced eddy current inspection time was the use of a drive probe pushing device that allowed switching probes and drivers to a new probe when the one in use was worn or damaged. The licensee reported that receiving inspection of the probes was performed to assure that no oversize probes were used during the inspection. This further reduced the problem with jammed probes.

Results

The initial eddy current of the OTSG placed both in Technical Specification category C2. The additional inspection required by the Technical Specifications placed them in Category C1. Table 1 is a summary of the inspections performed and the results of these inspections.

TABLE 1

Summary of the Eddy Current Inspection

Operation	Once Through Steam Generator 'A'	'B'
Plugged prior to this inspection	1247	359
Plugged during this inspection	13	8
Total plugged after the inspection	1260 - 8.1%	367 - 2.4%
Degraded prior to inspection (1)	243	21
Degraded after this inspection	262	26
Inspections Required by TS	1653	1425
Tubes inspected (bobbin coil) (2)	2791 - 14%	1938 - 12%
Tubes inspected (8X1 pancake coil)	311	59
Inspection Results		
Total defected/plugged	12/12	4/4
Total degraded/plugged (3)	19/1	5/4
Sludge removed (pounds)	113	178

(1) Primary side IGSCC caused by sulphur intrusion in 1981 (see NUREG 1019)
(2) Includes both initial and second inspection.
(3) Tubes that changed greater than 10% since the last examination.

Conclusions

The inspection results indicate that the tubes in the OTSG are not acting similarly since the 'A' generator has about 6% more plugged tubes than the 'B' generator. Since the sulphur intrusion in 1981 no new mechanisms for degradation of the OTSG has been observed. The licensee is trying to develop innovative ways to improve the eddy current testing by using the slower speed insertion and dual probe pushers to reduce inspection time and radiation exposures.

5.0 Data Analysis

Details of the Review

The eddy current contractor personnel were given approximately two and a half days of site specific training prior to being allowed to set up and perform any eddy current testing. This training included the usual site access training and in addition specific information on the OTSG, types of defects found in the past, specific information on how to report defects so direct comparisons with prior testing could be made and information on the evaluation and verification techniques to be used during the data evaluation. The inspector reviewed the records of this training and verified that all data analysts had received the information. During the review of the contractor certification records the inspector noted that several of the individuals had been at Three Mile Island Nuclear Power Station for the 1986 eddy current inspection of the OTSG.

The inspector reviewed the certifications of selected individuals in the eddy current testing contractors (CONAM) organization. All of the certifications reviewed met the requirements of SNT-TC-1A for the appropriate levels of certification for the tasks these individuals performed. The contractor had one Level III individual on site for the testing and data analysis.

The inspector determined that all eddy current test results were given two independent reviews by certified analysts. If differences between the analysts were found the Level III would resolve these differences. In the event the Level III was to reduce the defect size reported by an analyst from greater than the plugging limit to below the plugging limit, the Level III was required to get agreement from the original analyst. No licensee employees have been certified as Level III.

The inspector reviewed the results of selected tubes that were degraded in the 1986 inspection and compared these results of those reported in the 1988 inspection. In all cases examined the two results were within the limit of accuracy of the eddy current testing method.

Control of access to the primary and secondary system when these systems are opened is achieved by Administrative Procedure 1030. In accordance with this procedure when the system is open the area around the opening is designated an exclusion area unless exempted by the Shift Supervisor or Shift Foremen for small openings. Only essential tools and equipment are allowed into the exclusion area and the system opening. The Job Foremen determines the appropriate means of securing all loose objects carried into the opening. Any small tools that could fall out of sight and be missed during the final inspection prior to closing the opening are logged in and out of the opening. When required by the opening size and workscope an individual is assigned to the exclusion area to monitor tools and equipment entering and leaving the opening. During operation an accelerometer sensor based in the reactor coolant system and including the OTSGs records unusual sounds for analysis.

Conclusions

The site specific training for contractor personnel was adequate to assure that the results were reported uniformly so that direct comparisons with previous inspections could be made. Contractor personnel were qualified and certified to the appropriate levels as required by SNT-TC-1A. The method used for verification analysis of the data was adequate.

6.0 Engineering

Scope

The extent of engineering involvement with the OTSG inspection program was reviewed.

Details of the Review

The inspector interviewed individuals in the Site Engineering group to determine the scope of their involvement in the inspection of the OTSGs. From these interviews the inspector determined that the Site Engineering group was responsible for the initial selection of tubes to be examined, and if the inspection was to be escalated the selection of the tubes to be examined as a result of the escalation.

The Corporate Engineering section is primarily involved with the equipment aspects of the testing and performs a review function for plugging and tube stabilization to assure the proper tubes were plugged and stabilized.

The inspector reviewed the videotapes of the tube marking and plugging operation for the 'B' OTSG to assure that the appropriate tubes had been marked and plugged. The method used for marking the tubes on the top tubesheet was to use the same manipulator used during the inspection to identify and mark tubes to be plugged and/or stabilized.

Visual examination to verify that the correct tubes were marked was also employed. Color coding of the marking was used to identify tubes to be plugged only and a different color for tubes to be stabilized. Stabilized tubes had a length of tubing inserted and anchored in the area of the defect to prevent the tube from whipping if it failed even though it was plugged. To assure that the same tube was marked on the bottom tubesheet the licensee inserted a probe through the marked tube from the top and had an individual mark the bottom end where the probe exited. The inspector reviewed the videotapes of the marking and plugging operations for the 'B' OTSG to assure the correct defective tube had been marked and plugged. In all cases observed the correct tube had been marked and plugged.

Conclusions

Site Engineering was directly involved with the selection of tubes to be inspected. The videotapes clearly indicated which tubes had been marked and plugged and were relatively easy to follow based on the location of previously plugged tubes that were easy to see on the tape. The method of marking the bottom tubesheet to find the same tube was positive but did require that individuals involved be immediately outside the OTSG bottom opening and therefore exposed to relatively high radiation fields.

7.0 Secondary Water Chemistry

Scope

Water chemistry data was reviewed as part of the steam generator maintenance program. The methods of collecting and verifying the accuracy of these data were not included in the scope of this inspection.

Details of the Review

The plant has been operated with all volatile water treatment (AVT) since initial operation with hydrazine additions to control the pH and oxygen. During the last two months of operation before the refueling outage the licensee was experimenting with morpholine for pH and oxygen control and to assist in reducing the sludge buildup on the OTSG tube support plates. During this outage the results of this experiment were inconclusive.

Typically this buildup occurs on the third and fourth support plate from the bottom of the generator. To remove the buildup the licensee uses a water 'slap' technique to loosen the sludge followed by lancing for removal. The water 'slap' consists of lowering the water level to below the support plate to be 'slapped', then injecting nitrogen to cause the water to slap the support plate from below. This technique serves to open the flow passages in the support plates allowing improved flow during operation.

The licensee does extensive sampling of the secondary water at the following points in the system:

-- Condenser hotwells - nine sample points have been established for cation conductivity to aid in locating condenser leaks if any should occur.

-- At the condensate pump discharge there are in-line monitors for specific conductivity, cation conductivity oxygen, sodium and pH and grab samples can be taken at this point.

-- Cation conductivity is measured in each of the condensate demineralizers

-- After the condensate demineralizers cation conductivity, sodium and pH are measured with in-line monitors and there is a grab sample station at the monitors.

-- Specific conductivity and oxygen are measured after the low pressure feedwater pumps and before the low pressure feedwater heaters.

-- Located between the high pressure feedwater heaters and the OTSG are on-line monitors for sodium, cation conductivity, oxygen, pH, and hydrazine. There is also a grab sample point at this location.

-- In the main steam line there is a sample point for dose equivalent I-131, Tritium, sodium, pH and silica.

The inspector reviewed selected portions of the above samples to determine if the results are consistent with the EPRI guidelines for OTSGs. The results of this review are shown in Table 2.

TABLE 2

Secondary Water Chemistry Results

Location and Parameter	Licensee Results	EPRI Guideline
Condensate Pump Discharge		
Chlorides (ppb)	1	
Oxygen (ppb)	11	
Specific Conductivity UMHO/CM	5.85	
Cation Conductivity UMHO/CM	0.135	
Sodium (ppb)	0.4	
pH	9.41	
Feedwater		
Chlorides (ppb)	1	5 max
Specific Conductivity UMHO/CM	5.78	
Cation Conductivity UMHO/CM	0.092	0.2 max
Sodium (ppb)	0.5	3 max
Oxygen (ppb)	0.1	5 max
pH	9.44	9.3-9.6

In the last two years the licensee has upgraded the chemistry laboratory equipment by adding or upgrading the following equipment:

-- Replaced three sodium analyzers

-- Added a portable oxygen analyzer and upgraded two in the laboratory

-- Dedicated an ion chromatograph for use in determining secondary side water chemistry.

Conclusions

The licensee has maintained the secondary water chemistry parameters within the EPRI guidelines during periods of normal power operation. These benefits of good water chemistry control are reflected in the results of the eddy current testing described above.

8.0 Radiation Exposure

Scope

Radiation data was reviewed as part of this steam generator inspection and maintenance program inspection. The methods of collecting and verifying the accuracy of these data were not included in the scope of this inspection.

Details of the Review

The inspector reviewed the radiation exposure data for the 1983 OTSG eddy current inspection and discussed the efforts used to reduce this exposure with licensee personnel. Mock up training is used to prepare the individuals for the type of operations and access limitations to be expected during the inspection and repairs to the OTSG. The results of these reviews are shown in Table 3.

TABLE 3

Summary of radiation Exposures During 1988 Inspection

Units are Man-Rem

Operation	Total Exposure Both Generators
Installation and removal of manways	5.6
All eddy current testing operations	3.5
Water slap and lancing	5.8
Repairs - tube plugging stabilizer installation	7.8
Visual inspection before closing OTSG	2.2
All other operations	4.8
Total	29.7

Conclusions

The licensee has improved the methods used in eddy current testing by the use of dual probe pushers, slower insertion speeds and training in the mock-up. All of these actions have aided in reducing exposures during the eddy current inspection and repairs of the OTSG.

9.0 Licensee's Actions on Previous NRC Concerns

(Closed) Unresolved Item (86-13-06): Seismic analysis of the modification to Westinghouse DB-25 and DB-50 Breakers.

The inspector reviewed the amendment to the Amptector generic qualification report (WCAP 10449) for the modification to the Westinghouse DB-25 and DB-50 breakers. The seismic analysis had been verified as adequate for the modifications performed on these breakers including the mounting bracket design.

This item is closed.

(Closed) Unresolved Item (86-19-02): Seismic mounting of conduits and a domestic water line above the Category I two hour backup air supply in the 'B' diesel generator room.

The inspector reviewed the Plant Inspection Report (CS/33730/87) for the inspection of the welds and bolt torquing of the support connections for the conduit above the two hour backup air supply. The engineering analysis (memo 5320-87-2064) of the support for the 1/2 inch domestic water supply piping in this same location was reviewed. The inspector had no questions as to the adequacy of the seismic mounting of these items.

This item is closed.

(Closed) Unresolved Item (86-22-03): Removal of couplant after manual ultrasonic examination of stainless steel piping welds.

Procedure 6110-QAP-7209.06 required removal of couplant only if the stainless steel piping examined was operating above 150°F. Since the inspection personnel did not necessarily know, nor were they required to know, the operating conditions of the piping they examined this left in doubt whether all piping operating over 150°F was cleaned as required. The licensee revised this procedure to require the couplant be removed from all stainless steel piping after all manual ultrasonic examinations.

This item is closed.

10.0 Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items or violations. Unresolved items are discussed in paragraph 9.

11.0 Management Meetings

Licensee management was informed of the scope and purpose of the inspection at the entrance interview on July 25, 1988. The findings of the inspection were discussed with licensee representatives during the course of the inspection and presented to licensee management at the July 29, 1988 exit interview (see paragraph 1 for attendees).

At no time during the inspection was written material provided to the licensee by the inspector. No proprietary information has been included in this report.