U. S. NUCLEAR REGULATORY COMMISSION
REGION I

DOCKET/REPORT NO: 50-443/94-09

LICENSEE: North Atlantic Energy Service Corporation
Seabrook, New Hampshire 03874

FACILITY: Seabrook Nuclear Power Station

DATES: April 25-29, 1994; May 2-6, 1994; and May 16-20, 1994

INSPECTORS: P. Patnaik 6-8-94
Prakash Patnaik, Reactor Engineer Date
Materials Section
Division of Reactor Safety

for P. Patnaik 6-8-94
Robert McBrearty, Reactor Engineer Date
Materials Section
Division of Reactor Safety

APPROVED BY: Michael C. Modes 6/8/94
Michael C. Modes, Chief Date
Materials Section
Division of Reactor Safety

Areas Inspected: An announced safety inspection was conducted to review the in-service inspection (ISI) program, the eddy current examination program for steam generator tubes, the steam generator tube leakage monitoring program, and the qualification of steam generator tube plugs.

Results: Overall, the ISI program was found to be good and satisfactorily implemented. The scope of in-service inspection work during the outage was found to be in compliance with the applicable ASME Section XI Code and the regulatory requirements. The eddy current examination of steam generator tubes exceeded the requirements of the technical specifications. The steam generator leakage monitoring program lacked procedural control for small primary-to-secondary tube leaks and, hence, constituted a noncited violation in accordance with Section VIIB of 10 CFR Part 2, Appendix C. However, the licensee took prompt, corrective action to revise appropriate procedures to address the small tube leaks. The results of tests on qualification of steam generator tube plugs assured integrity of the pressure boundary against primary-to-secondary leaks.

DETAILS

1.0 IN-SERVICE INSPECTION (ISI) 73753)

1.1 Scope

The conduct of in-service inspections using ultrasonic, magnetic particle liquid penetrant, and visual examination methods helps to ensure the integrity of the pressure boundary. During this inspection, reviews of the 10-year ISI plan, the scope of work for the third refueling outage, and observation of work activities were performed to ascertain if the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, and the technical specifications were met. Also during this inspection, the steam generator tube examination program, the steam generator tube leakage monitoring program, and the qualification of mechanical plugs for steam generator tubes, were reviewed.

1.2 Findings

1.2.1 Reactor Pressure Vessel Beltline Welds - Augmented Volumetric Examination

On September 8, 1992, when the requirement became effective for performing an augmented, volumetric examination of reactor pressure vessel welds specified in ASME Code, Examination Category B-A, Item B1.10, Seabrook had more than 40 months remaining in its 10-year in-service interval. Because of that and in accordance with the rule, the licensee cannot defer until the first period of its next inspection interval and the performance of the augmented examination.

There are 12 welds at Seabrook in Item B1.10 of Category B-A, and all are scheduled for examination during the third period of the current inspection interval. The licensee intends to perform the augmented examination at that time and will document the percentage of required volume that can be examined. The requirement is that, essentially, 100% of the weld volume must be examined. Essentially, 100% is defined as "greater than 90% During the performance of the preservice examination (PSI) of the subject welds, three welds were examined for less than 90% of their required volume. Those welds are identified in relief request IR-1, which was submitted by the licensee to the NRC to obtain relief from examining portions of vessel welds that were inaccessible to 100% examination during the PSI.

The licensee is aware that, as stated in Title 10 of the Code of Federal Regulations, paragraph 50.55(a)(g)(6)(ii)(A)(1), all previously-granted reliefs under 50.55(a) to licensees for the extent of volumetric examination of reactor vessel shell welds specified in Item B1.10 of Examination Category B-A are revoked. The licensee has noted in the first 10-year interval in-service inspection program plan that three reactor vessel shell welds in IR-1 that did not meet the minimum ASME code coverage requirements would require reverification of examination coverage at the end of the 10-year interval and subsequent resubmittal of a request for relief, if applicable.

1.2.2 Observations of Work in Progress

In-service inspections that were conducted during the ongoing refueling outage included visual inspection of the reactor pressure vessel (RPV) closure head and flange, and the wet, fluorescent-magnetic particle examination of RPV studs and nuts.

The visual inspections were performed by NES, Incorporated, the licensee's contractor, using a color video camera, and the results were recorded on videotape. The flange inspection was accomplished with a remotely-operated underwater camera, and the taped results of both inspections were evaluated by the contractor's Level III examiner.

The activity was witnessed by the inspector to determine whether the tapes were of sufficient quality to be considered as a permanent record of the inspection and to ascertain that the Level III evaluation was consistent with the recorded results.

The taped color images were found to be of excellent quality. The camera movement and the focus was such that clear, sharp images were recorded.

Based on the inspection results, the RPV flange was judged to be acceptable for continued service.

The RPV closure head inspection revealed an indication on the inside surface of the head that was originally detected during the last refueling outage. The indication had increased in size during the last operating cycle. Upon review of the videotape recording of the current visual inspection, two additional very small indications were identified. The licensee was unable to identify the nature or cause of the indication by viewing the videotape and concluded that further investigation was required. The decision was made to photograph the visual indications using a 35 mm still camera and, if possible, to obtain, for metallurgical analysis, a sample of the material comprising the indication.

Because of the high radiation field associated with the inside surface of the Unit 1 closure head, the Unit 2 head was used as a training mockup to familiarize the photographer with the conditions that he would encounter at Unit 1 and to minimize the time in the radiation field.

The inspector witnessed the training activity and noted that it was performed as realistically as possible. The indication locations were clearly marked on the head surface, and the photographer was required to wear the same type of protective clothing as would be required in Unit 1. Additionally, the camera was fitted with a standoff rod to allow prefocussing the camera at a predetermined distance, thereby eliminating the need to focus it for each exposure. Additionally, a motorized window was attached to the camera to automatically advance the film after each exposure. Health Physics personnel were present to monitor the activity and to assure that all possible precautions were taken to minimize the photographer's stay time in the radiation area. The three simulated indications were photographed on a 24-exposure roll of film, as directed by the licensee's Level III examiner, to estimate the time necessary to complete the photography and to determine whether prefocussing the camera resulted in clear, sharp prints. The results of the training were encouraging in that the time necessary to obtain 24 exposures was less than two minutes and the resulting photographs were of good quality. Combustion Engineering has been contracted to analyze any material that can be obtained from the largest of the three indications and to interpret the still photographs in an attempt to characterize the indications.

At the time the inspector left the site on May 20, 1994, the closure head was still on the Unit 1 reactor vessel, and the above-described activities had not been performed in Unit 1. The head had been placed on the vessel to complete scheduled activities subsequent to the initial visual inspection that detected the indications.

The magnetic particle examination of RPV studs and nuts was performed by NES, Incorporated, during this refueling outage. A portion of the activity was witnessed by the inspector to determine whether the examination was performed in accordance with the applicable procedure by qualified examiners.

The technique made use of the wet, fluorescent-magnetic particle examination method. The examination area was enclosed to eliminate as much light as possible from the work area as required by the fluorescent method.

The inspector's observations confirmed that the two examiners were knowledgeable of the method and were qualified to perform the examination. All of the precautions were observed, including a minimum of a five-minute warmup period for the black light and the use of an appropriate light meter to verify that the black light intensity complied with procedural requirements.

Magnetic particle indications were detected during the examination, and a review of the examination data confirmed that those indications were properly documented and evaluated against appropriate acceptance criteria. All of the indications were within acceptable limits; and, hence, all of the studs and nuts were deemed to be acceptable for continued service.

Prior to performing the examination, the contractor's examiners were given training in the fluorescent method and were required to pass a practical examination demonstrating their ability to use the wet, fluorescent method.

Conclusions

The videotape recording of the visual inspection of the reactor vessel closure head and flange was of excellent quality.

Actions taken by the licensee to aid in the evaluation of the visual indications observed on the closure head inside surface were appropriate, and the use of the Unit 2 closure head as a mockup to prepare for further investigation of those indications was in evidence of licensee's desire to determine the cause and the nature of the indications, and at the same time, to protect plant personnel from exposure to radiation to the greatest extent possible.

The magnetic particle examination of the reactor pressure vessel studs and nuts was performed by qualified examiners using an extremely sensitive technique.

2.0 STEAM GENERATOR TUBE EDDY CURRENT EXAMINATION AND STATUS OF SEABROOK STEAM GENERATOR TUBES

The licensee performed an eddy current examination of tubes in two of the four steam generators. Tubes in the "B" and"C" generators were selected for examination during the current third refueling outage of the first 10-year inspection interval. North Atlantic Energy Service Corporation, the licensee, intends to follow the Electric Power Research Institute (EPRI) guidelines that recommend that 100% of the tubes in all four steam generators be examined over five consecutive refueling outages. Greater than 40% of the 5,626 tubes in each of the two steam generators were examined over their full length, and 103 tubes in each generator were examined over the cold leg straight and U-bend sections to complete the examination of those tubes that were examined in 1991 over the hot leg straight and U-bend portions. Also, all tubes examined previously that displayed indications of 20% and greater wall loss and any tubes reported to have anti-vibration bar (AVB) wear, regardless of wall loss, were examined at this time.

Examination data analysis was performed by primary and secondary reviewers employed by the Westinghouse Electric Corporation, the licensee's contractor. That analysis was performed, by telephone link, at the Westinghouse Waltz Mill facility. Discrepancies arising from the primary and the secondary analysis were resolved by resolution analyst shift supervisors stationed at the Seabrook site.

The Yankee Nuclear Services Division (YNSD) Eddy Current, Level III, examiner performed surveillance of the contractor and reviewed results of selected bobbin coil eddy current examinations and all motorized rotating pancake coil examinations. The YNSD Level III examiner also reviewed all procedures, guidelines, and conducted training and qualification prior to the performance of eddy current examinations.

All of the analysts were trained, either on site at Seabrook or at Waltz Mill, in accordance with the Seabrook Steam Generator Eddy Current Analysis Guideline Manual and were required to pass a written, specific examination and a practical examination consisting of typical indications found in Model F steam generators.

The steam generator tube status, including the latest results, is as follows:

Overall Results

Defective - Plugging Required	>40% wall loss	1 tube
Degraded	20%-39% wall loss	103 tubes
Imperfections	1%-19% wall loss	50 tubes
Imperfections	No associated wall loss	298 tubes

Eddy Current Examination Results - 1994

Indication Type	S/G B	S/G C
Wall Loss Flaws		
Defective Tubes (≥40% wall loss)	1	0
AVB Wear Degraded Tubes (20%-39% wall loss)	10	20
Other Degraded Tubes (20%-39% wall loss)	7	14
AVB Wear Imperfections (1%-19% wall loss)	14	24
Other Imperfections (1%-19% wall loss)	6	6
Other Non-Quantifiable Signals (<40% wall loss)	24	28

Other Types of Imperfections

Manufacturing Burnish Marks	89	45
Dents and Dings	122	42

NOTE: The AVB wear is the only condition that appears to be service-related.

Severity of AVB Wear Indications

AVB Severity	Number of Tubes with AVB Wear	
	S/G B	S/G C
>40%	1	0
30%-39% wall loss	3	2
20%-29% wall loss	7	18
10%-19% wall loss	14	24
Total	25	44

NOTE: The defective tube, which was plugged, exhibited wall loss of 55%. The tube had not been examined since the baseline examination in 1985. The first in-service eddy current examination was performed in August 1991, during the first refueling outage when tubes in all four steam generators were examined.

Steam Generator Plugging History

	S/G A	S/G B	S/G C	S/G D	Total
Fabrication	3	2	5	0	10
Preservice	1	2	0	0	3
RFOI	0	1	8	1	10
RF02	0	-	-	0	0
RF03	-	1	0	-	1
Total	4	6	13	1	24

Conclusions

The licensee continues to perform eddy current examination of their steam generator tubes in excess of the technical specification requirements. The plant is operated such that the steam generator tube integrity is not compromised, which may be noted from the small number of tubes that have been removed from service since the plant became operational (one tube required plugging during the 1994 refueling outage, and a total of 24 tubes have been plugged in all four steam generators. This total includes 13 tubes that were plugged prior to the commencement of commercial operation).

3.0 STEAM GENERATOR TUBE LEAKAGE MONITORING PROGRAM

The following procedures are used to detect, monitor, and control leakage of reactor coolant from primary to secondary through steam generator tubes. The inspector reviewed the procedures to ensure that they provided adequate guidance and effectively controlled radiation to the environment due to primary-to-secondary coolant leakage.

Procedure Title No.	Purpose
Steam Generator Tube Leak Procedure No. 051227.02, Rev. 3	To safely shut down and cool down the plant with a steam generator tube leak in progress that does not require a reactor trip or safeguards actuation.
Primary-to-Secondary Leakrate Calculation Procedure No. CSO920.05, Rev. 4, d	escribes the method for determination of primary-to-secondary leakrates.
Secondary Coolant System Activity Procedure No. CX0901.20, Rev. 6	To ensure compliance with the Technical Specification monitoring for gross radioactivity and dose equivalent Iodine 131 in secondary coolant.
Process or Effluent High Radiation Procedure No. 051252.01, Rev. 6	To provide actions to identify and verify the isolation of systems due to a high radiation alarm and to minimize radiation release.
Chemistry Response to Radiation Data Management System (RDMS) Failure or Alarm Procedure No. CSO905.10, Rev. 0	To ensure compliance with technical specifications in the event of an RDMS monitor failure and to ensure proper response to an audit or high alarm on any RDMS monitor.

The inspector determined that the above procedures, as implemented, effectively addressed the licensee's actions against gross primary-to-secondary leakage of the magnitude equal to or greater than that of the limiting technical specification leakage of 500 gallons per day. However, the procedure No. OS 1227.02, Rev. 3, "Steam Generator Tube Leak," provided no action plan for operation of the plant with a small tube leak from inception to its ultimate disposition of an orderly plant shutdown at a limiting leakage rate to mitigate an event of a tube rupture.

The Technical Specifications, Section 6.7.1, however, states, "written procedures shall be established, implemented, and maintained covering the activities referenced below:

A. The applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2, February 1978.

The item No. 6(a) in Appendix A to Regulatory Guide 1.33 recommends a procedure against loss of coolant (including significant PWR steam generator leaks) (inside and outside primary containment) (large and small, including leakrate determination). Since the licensee had no written procedure against loss of reactor coolant due to small primary-to-secondary leak in steam generator tubes, as required by the Regulatory Guide 1.33, Revision 2, this was a violation of the Technical Specification requirement stated in Section 6.7.1. In accordance with 10 CFR Part 2, Appendix C, this constituted a Severity Level V violation due to its minor safety or environmental significance. The inspector noted that the licensee had previously identified the need to develop action plans against minor steam generator tube leakage. Further, this violation could not have been prevented by the licensee's corrective actions for any previous violation, and this was not a willful violation. Hence, the inspector determined that this was a noncited violation, since it met all the criteria set forth in Section VII B of 10 CFR Part 2, Appendix C. However, the licensee took prompt, corrective action and revised the existing steam generator tube leak procedure to encompass small primary-to-secondary tube leaks. The corrective action was completed prior to the end of the inspection.

4.0 QUALIFICATION OF MECHANICAL PLUGS FOR STEAM GENERATOR TUBES

The defective tubes in Seabrook steam generators are plugged using mechanical plugs fabricated from thermally-treated alloy 690 material. During this inspection, the inspector reviewed reports on qualification of mechanical plugs. The inspector noted that the plugs satisfied the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section III for Class I pressure boundary components and the installation met the requirements of the ASME Code, Section XI. The qualification test consisted of hydrostatic and leak tests, thermal and pressure cycling, and axial pull tests. In addition to the qualifications tests, a variety of tests were performed to further establish performance. These included the following tests:

- Leak testing of the plugs at operating temperature of the steam generator prior to life cycling;
- Leak testing of the plugs at a higher operating temperature after life cycling;
- Extended six-hour leak tests; and
- Hydrostatic tests at increasing pressures until the plug or tube began to leak.

All of the above tests were conducted on tube and plug assemblies applicable to Seabrook steam generator. The results of tests assured the integrity of the mechanical plug against primary-to-secondary leaks in normal, emergency, or faulted operation.

5.0 EXIT MEETING

The findings of the inspection were presented to, and discussed with, members of the licensee's management at the exit meetings conducted on April 29, 1994, and May 20, 1994. The licensee concurred with the findings of the inspection. A list of attendees of the exit meeting on May 20, 1994, is attached to this report as Attachment 1.

ATTACHMENT 1

Licensee Attendees

Bruce Benchel, Mechanical Engineering Manager
W. A. DiProfio, Station Manager
B. L. Drawbridge, Executive Director, Nuclear Director of Nuclear Production
J. M. Grillo, Operations Manager
G. A. Kann, Program Support Manager
R. B. McCormack, Lead Engineer, ISI
G. F. McDonald, Nuclear Quality Manager
J. L. Peterson, Maintenance Manager
J. Sobotka, NRC Coordinator
F. J. Sowctoky, Technical Projects Supervisor
K. Whitney, ISI Coordinator

NRC Attendees

A. Cerne, Senior Resident Inspector
R. McBrearty, Reactor Engineer, DRS