New Hampshire
Yankee

Ted C. Feigenbaum
President and
Chief Executive Officer

NYN-91168

October 18, 1991

United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

Reference: (a) Facility Operating License No. NPF-86, Docket No. 50-443

(b) NRC Bulletin 88-09, dated July 26, 1988, "Thimble Tube Thinning in Westinghouse Reactors"

(c) New Hampshire Yankee letter NYN-90010 dated January 11, 1990, "Information Regarding Incore Instrumentation Thimble Thinning," T. C. Feigenbaum to USNRC

Subject: Completion of Incore Instrumentation Thimble Initial Inspections

Gentlemen:

NRC Bulletin 88-09 requested licensees to establish an inspection program to monitor thimble tube performance using an inspection methodology capable of adequately detecting thimble tube wear. In a letter dated January 11, 1990 [Reference (c)], New Hampshire Yankee (NHY) committed to develop an inspection program to monitor thimble performance and to perform the initial thimble inspections during the first refueling outage of Seabrook Station.

This letter confirms that an inspection program to monitor incore instrument thimble tube performance has been established and implemented in accordance with NRC Bulletin 88-09. Enclosure 1 specifically discusses the program's inspection methodology, frequency, acceptance criteria, and the unique design features at Seabrook Station that provide increased resistance to tube thinning. The enclosure also provides the results of the inspections conducted during Seabrook Station's first refueling outage. Specifically, these inspections revealed that no degradation of either the inner calibration tube or the outer housing tube has been detected. Based on this, NHY concludes that no corrective actions are necessary at this time.

The incore instrument system at Seabrook Station has some unique design features. Based on the results of this inspection, in conjunction with these unique design features, NHY has determined that housing tube wear would not present the potential for calibration tube wear during the next two operating cycles. This determination was made assuming a hypothetical worst case scenario. Therefore, the next incore instrumentation thimble inspection will be conducted during the third refueling outage of Seabrook Station.

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Should you require further information regarding this matter, please contact Mr. Geoffrey Kingston at (603) 474-9521, extension 3371.

Very truly yours,

Ted C. Feigenbaum

TCF:JES

Enclosure

STATE OF NEW HAMPSHIRE

Rockingham, ss. October 18, 1991

Then personally appeared before me, the above-named Ted C. Feigenbaum, being duly sworn, did state that he is President & Chief Executive Officer of the New Hampshire Yankee Division of Public Service Company of New Hampshire, that he is duly authorized to execute and file the foregoing information in the name and on the behalf of New Hampshire Yankee Division of the Public Service Company and that the statements therein are true to the best of his knowledge and belief.

Tracy A. DeCredico, Notary Public
My Commission Expires: October 3, 1995

cc: Mr. Thomas T. Martin
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New Hampshire Yankee
October 18, 1991

ENCLOSURE 1 TO NYN-91168

SEABROOK STATION UNIT 1
INCORE INSTRUMENT INSPECTION AND MONITORING REPORT

A. Introduction

NRC Bulletin 88-09 requested licensees to establish an inspection program to monitor thimble tube performance using an inspection methodology capable of adequately detecting thimble tube wear. In a letter dated January 11, 1990 (NYN-90010), New Hampshire Yankee (NHY) committed to develop an inspection program to monitor thimble performance and to perform the initial thimble inspections during the first refueling outage of Seabrook Station.

This report confirms that an inspection program to monitor incore instrument thimble tube performance has been established and implemented in accordance with the provisions of NRC Bulletin 88-09. The specific inspection methodology, frequency and acceptance criteria are discussed below. This report also provides the results of the inspections conducted during the first refueling outage at Seabrook Station. During these inspections no observable wear of the thimble tubes was detected, and therefore, no corrective actions are necessary at this time.

B. Background

The Seabrook Station Fixed/Movable Incore Instrumentation System employs unique design features that provide increased resistance to tube thinning from abrasive wear and in-depth protection against reactor coolant leakage resulting from thimble tube failure. These design features include: a double-concentric thimble tube fabricated from wear-resistant, seamless inconel 600 material, tight thimble-to-support column clearance, seal table isolation valves and multiple leakage detection means. Each design feature and its contribution to reducing the probability of occurrence and/or consequences of thimble failure due to wear is discussed below:

- Double, concentric thimble tube design. Each of the fifty-eight (58) Seabrook Station incore instrument thimbles consist of an outer tube called a "housing tube" containing five fixed flux detectors and one fixed thermocouple on an inner calibration tube. (See Figure 1 for a cross section of a Seabrook Station thimble tube). The moveable neutron flux detector travels inside the calibration tube. The calibration tube is considered the reactor coolant pressure boundary; however, the housing tube can also withstand Reactor Coolant System (RCS) pressure. In the event of failure of the housing tube, reactor coolant would be contained by the calibration tube and the seal table. A failure of both the housing tube and the calibration tube would be required before reactor coolant would leak into the Containment.

- Housing/calibration tube material. The housing and calibration tubes are fabricated from seamless Inconel 600. This material is harder and more resistant to wear from abrasion than stainless steel. The seamless design further increases tube strength.

- Thimble-to-instrument support column clearance. The Seabrook reactor design results in a clearance between the housing tube outside diameter and the instrument support column inside diameter of 0.035 inches. (The instrument support column is a component in the lower core support structure located below the fuel bottom nozzle.) This compares to clearances ranging between 0.080 and 0.150 inches in other standard in-core instrument system designs. Operating data from other plant sites indicate that reduced clearances between the thimble and the support column result in reduced thimble wear.

- Leakage detection capability. A failed housing tube would cause abnormal indications on one or more of the fixed detectors and/or thermocouples within the failed thimble. In the unlikely event of failure of both the housing and the calibration tubes, reactor coolant would leak through the calibration tube past the seal table into one of the moveable detector ten-path transfer devices. Leakage into the ten-path transfer devices is collected in a drain header, detected, audibly and visually alarmed on the system control panel in the Computer Room adjacent to the Control Room. At the alarm level, a solenoid valve opens automatically to drain the leakage to a Containment sump. Additional indications of thimble/calibration tube failure could include increased Containment radioactivity levels, detectable by a radiation monitor located near the seal table.

- Leakage isolation capability. The Seabrook Station incore instrumentation system includes manual isolation valves at the seal table which can be used to terminate leakage from a completely failed thimble; i.e., both housing and calibration tubes failed.

Notwithstanding the above described unique design features at Seabrook Station, NHY has developed and implemented an inspection program in accordance with NRC Bulletin 88-09. Section C of this report describes the inspection program.

C. Inspection Program

In accordance with the criteria provided in NRC Bulletin 88-09, NHY developed the Seabrook Incore Instrument Thimble Inspection and Monitoring Program. To assist with implementation of this program, NHY retained the services of Cramer & Lindell Engineers, Inc. (C&L) of Niantic Connecticut, to develop a Seabrook-specific eddy current inspection procedure, and to design and manufacture the required inspection equipment. C&L is recognized for its expertise in the field of incore thimble eddy current inspections. C&L also conducted the inspections of the 58 incore thimbles. The inspection program methodology and rejection criteria are discussed below.

C.1 Inspection Methodology

NHY conducted the thimble tube inspections by inserting eddy current probes into the calibration tubes. Access to the tubes was achieved through the Incore Instrumentation (ICI) Seal Table. The probe was driven by a mechanized positive drive connected to each detector path by rigid tubing. The drive unit could provide constant or variable drive speed to the probe and was equipped with a distance counter to indicate probe position within the

calibration tube. Eddy current measurements were taken along the entire length of the thimble tubes during retraction of the probe. The data were displayed on-line to permit immediate on-site identification of unusual conditions or gross tube damage. Following the data acquisition, the signals were reanalyzed with a computerized Data Analysis System and the results documented in support of the C&L report.

The eddy current method used in the inspection of the Seabrook thimbles utilized four probe frequencies due to the double wall concentric tube design. The inner calibration tube wall was inspected at frequencies of 600 and 200 KHz. The calibration tube is the less challenging of the two concentric tubes to inspect because the tube wall is adjacent to the probe and separated from the probe by only air. Therefore the 600 and 200 KHz frequencies provided a well defined response from the calibration tube wall in detecting potential wall loss on both the inside and outside diameters of the calibration tubes. The 600 and 200 KHz frequencies were each analyzed separately, and together, using a vector addition technique to cancel out signals originating outside the calibration tube wall. The two distinct frequency signals and the mixed signal were analyzed with both phase angle and amplitude analysis. With this analysis technique the phase angle is used to assess the physical location and nature of the structure responsible for a particular signal response. Signal amplitude is used as a measure of wall loss. Utilization of the foregoing technique allows for detection of wall loss as low as 10 percent of the calibration tube wall thickness.

Performing the eddy current inspection of the housing tubes requires a more demanding analysis since the housing tubes are separated from the eddy current probes by the calibration tube wall and the thermocouple and fixed detector leads. (See Figure 1). The analysis used to evaluate the housing tube involved three frequencies: 30 KHz, 60 KHz and 200 KHz. The 30 and 60 KHz signals provided good signal penetration of the outer housing tube while the 200 KHz signal was constrained to within the housing tube inside diameter. The phase analysis was performed on the 200 KHz signal and the 200/30 KHz mix. Amplitude analysis was performed on the 200/30 KHz mix and a 200/60 KHz mix. This technique was utilized since it provided good sensitivity to known defects in a demonstration standard fabricated from a thimble segment manufactured in the same lot as the Seabrook thimbles. Utilization of this technique allows for detection of wall loss as low as 20 percent of the housing tube wall thickness.

C.2 Inspection Rejection Criterion

As previously discussed, the inner calibration tube was designed to withstand reactor coolant system pressure. Based on this, the ultimate integrity of the thimble, and therefore the potential for a reactor coolant system leak, depends not only on the integrity of the housing tube, but also on the integrity of the calibration tube. Therefore, a reasonable inspection rejection criterion is the observed failure of the housing tube in conjunction with degradation of the calibration tube wall. For the purpose of the initial thimble tube inspection, NHY has simplified the inspection rejection criterion by conservatively limiting it to the observation of any measurable wear on the outside diameter of the calibration tube.

D. <u>Inspection Implementation and Results</u>

NHY conducted the incore thimble inspections during reassembly of the reactor vessel toward the end of the first refueling outage. The actual field measurements were obtained

on September 15, 1991, and the inspections were completed on September 18, 1991, with receipt of the preliminary C&L report. This report indicated that no observable wear of the outer housing tubes was detected. The results also indicate that no degradation of the inner calibration tube had occurred.

In accordance with the requirements of NRC Bulletin 88-09, records generated during the development of the inspection program as well as progress reports and results of the subject inspections are available and are on file at Seabrook Station.

E. Inspection Frequency

Since the initial indications of housing tube wear are less than the minimum observable of 20 percent of the tube wall thickness, and there were no indications of wear on the calibration tubes, NHY will conduct the next thimble tube inspection during the third refueling outage. NHY's technical basis for this inspection frequency is discussed below.

Based on the results of the inspections performed, the hypothetical worst case degradation of the outer housing tube that could have occurred is the minimum observable of 20 percent of the tube wall thickness. If one assumes that this degradation is linear, then the wear rate of the housing tube over the previous 12 months of operation was 1.67 percent per month. Since the next inspection is scheduled to occur after an additional 29 months of operation, a hypothetical worse case accumulated wear of the housing tube would be:

$$20\% + (29 \text{ mo.} \times 1.67\%/\text{mo.}) = 68.4\%$$

Thus, under this assumption, the outer housing tube would not completely wear through by the end of the third cycle of operation. Notwithstanding this, however, NHY recognizes that housing tube failure may occur before 68 percent wear is reached

Since Seabrook Station utilizes the double wall design, it would require significantly more than this amount of degradation of the outer housing tube and associated instrumentation leads to produce wear on the inner calibration tube. For the thimble tube supports to come into contact with the inner calibration tube such that the potential for wear exists, a large portion of the outer housing tube and instrumentation leads would have to completely wear through. It is estimated that approximately one-third of the circumference of the outer housing tube would have to wear through before calibration tube/support contact could occur.

Based on the foregoing, NHY concludes that the next thimble tube inspection should be conducted during the third refueling outage.

F. Corrective Actions

NHY has determined that since no measurable calibration tube wear has been detected, no corrective actions are necessary at this time.

G. Conclusion

Based on the foregoing, NHY has concluded that Seabrook Station Unit I can operate safely during Cycles 2 and 3 with no degradation of the incore instrument thimble calibration tubes. Additional eddy current inspections will be performed during the third refueling outage to determine the extent of wear on the incore instrument thimble housing tubes.

Figure 1

Cross section of double wall concentric thimble tube