North Atlantic

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The Northeast Utilities System

Ted C. Feigenbaum
Senior Vice President &
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NYN-
October 23, 1995

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

Attention: Document Control Desk

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

(b) "NRC Generic Letter 95-03: Circumferential Cracking of Steam Generator Tubes," April 28, 1995

(c) J. F. Opeka to U.S. Nuclear Regulatory Commission, "Haddam Neck Plant, Millstone Nuclear Power Station, Unit Nos. 2 and 3, Seabrook Station Response to Generic Letter 95-03," B15277, June 27, 1995

(d) A. W. De Agazio (NRC) to T. C. Feigenbaum, "Request for Additional Information Related to Generic Letter 95-03," September 12, 1995

(e) A. W. De Agazio to A. L. Legendre, "Additional Question," October 13, 1995

Subject: Response to Request for Additional Information Related to Generic Letter 95-03

Gentlemen:

The NRC issued Generic Letter 95-03 requesting information from all PWR plants regarding circumferential cracking of steam generator tubes on April 28, 1995 [Reference (b)]. Northeast Utilities responded to Generic Letter 95-03 for CY, MP2, MP3, and Seabrook Station on June 27, 1995, [Reference (c)]. The NRC has reviewed the NU response to Generic Letter 95-03 and has requested additional information relative to Seabrook Station, [References (d) and (e].

The requested information pertains to the following areas identified as being susceptible to circumferential cracking:

a. Small radius U-bends
b. Dented locations
c. Sleeve joints

The enclosure to this letter provides responses to each of the above areas.

Should you have any further questions please contact Mr. James M. Peschel at (603) 474-9521 extension 3772.

Very truly yours,

Ted C. Feigenbaum

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ENCLOSURE TO NYN-95083

SEABROOK STATION RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION RELATED TO GENERIC LETTER 95-03

The NRC requested the following information on September 12, 1995 [Reference (d)]:

Responses to the following are provided herein in Sections 1 through 6:

> The following areas have been identified as being susceptible to circumferential cracking:
>
> a. Expansion transition circumferential cracking
> b. Small radius U-bend circumferential cracking
> c. Dented location (including dented TSP) circumferential cracking
> d. Sleeve joint circumferential cracking
>
> In your response, areas b, c, and d were not specifically addressed, although it was indicated that no thermally treated tubing in domestic Model F steam generators have exhibited circumferential cracking. Please submit the information requested in Generic Letter 95-03 per the guidance contained in the generic letter for these areas (and any other area susceptible to circumferential cracking).
>
> The staff realizes that some of the above areas may not have been addressed since they may not be applicable to your plant; however, the staff requests that you clarify this (e.g., no sleeves are installed; therefore, the plant is not susceptible to sleeve joint circumferential cracking).
>
> For dented locations, if applicable, the criteria for determining which dents are/were examined should be provided. If a dent voltage threshold is used for such a determination, the calibration procedure used (i.e., 4.0 volts on 4-20% through-wall ASME holes at 550/130 mix) should be provided.

The NRC requested the following additional information on October 13, 1995 [Reference (e)]:

Responses to the following are provided herein in Section 7.

> During the Maine Yankee outage in July/August 1994, several weaknesses were identified in their eddy current program as detailed in NRC Information Notice 94-88, "Inservice Inspection Deficiencies Result in Severely Degraded Steam Generator Tubes." In Information Notice 94-88, the staff observed that several circumferential indications could be traced back to earlier inspections when the data was reanalyzed using terrain plots. These terrain plots had not been generated as part of the original field analysis for these tubes. For the rotating pancake coil (RPC) examinations performed at your plant at locations susceptible to circumferential cracking during the previous inspection (i.e., previous inspection per your Generic Letter 95-03 response), discuss the extent to which terrain plots were used to analyze the eddy current data. If terrain plots were not routinely used at locations susceptible to circumferential cracking, discuss whether or not the RPC eddy current data has been reanalyzed using terrain mapping of the data. If terrain plots were not routinely used during the outage and your data has not been reanalyzed with terrain mapping of the data, discuss your basis for not reanalyzing your previous RPC data in light of the findings at Maine Yankee.
>
> Discuss whether terrain plots will be used to analyze the RPC eddy current data at locations susceptible to circumferential cracking during your next steam generator tube inspection.

1.0 INTRODUCTION

NRC letter, Serial No. SEA 95-020, dated September 12, 1995, requested additional information related to Generic Letter 95-03. The information requested pertained to circumferential cracking in small radius U-bends, dented locations, and sleeve joints. The following discussion provides the information requested.

2.0 AREAS POTENTIALLY SUSCEPTIBLE TO CIRCUMFERENTIAL CRACKING

Those locations, where a change in geometry occurs, increase the potential for tube cracking. Small radius U-bends, dented locations, and sleeve joints represent locations of increased tube stress and, therefore, have an increased potential for cracking. Since no sleeves have been installed at Seabrook, the tubes are not susceptible to sleeve joint cracking. The design of the Seabrook Model F steam generators included methods to reduce the potential for tube cracking in both U-bend and dent locations. Specifically:

1. Thermally treated Inconel 600 tubing reduces the potential for tube cracking versus mill annealed tubing. (No thermally treated tubing in domestic Model F plants has experienced cracking.)

2. Stress relief performed in the U-bend region of Rows 1 through 10 has further reduced the potential for crack initiation.

3.0 PREVIOUS NDE SCOPE AND RESULTS

Small Radius U-bends

In May 1994 (RFO 3), approximately 30 percent of the Row 1 and Row 2 U-bends in two of the four steam generators (SGB and SGC) were examined using a bobbin coil probe. No indications of tube cracking were identified.

Dented Locations

In May 1994 (RFO 3), approximately 40 percent of the tubes in two of the four steam generators (SGB and SGC) were examined full length using a bobbin coil probe. All bobbin coil data was reviewed for denting. Plant specific data analysis guidelines required the analysts to report dents. The analysts were trained for performing dent analysis prior to the start of the examination. Dents at tube support and top of tubesheet location were reported as 'DNT.' A dent was reported when the signal produced by the support suppression mix (630/150 kHz differential) was greater than or equal to 5 volts.

Dents in free span tubing (dings) were reported as 'DNG.' A ding was reported from the 630 kHz differential channel, with no voltage threshold applied.

The voltage was calibrated by setting the signal produced by the four 20 percent through-wall ASME holes on the 630 kHz differential channel to 4.0 volts. The voltage on the 630/150 kHz differential support suppression mix was normalized in reference to the 630 kHz differential channel.

Using the preceding criteria, a total of approximately 400 locations in SGB and SGC were identified as containing dents or dings. Many of the reported dent indications were the result of geometry variations associated with the tangent point of the bend and were not "typical" dents. During the previous two outages (RFO 2 and RFO 3), a total of 12 dent locations were examined by rotating probe techniques. The examinations included tubes from all four steam generators. No indications of tube cracking were identified.

4.0 JUSTIFICATION FOR CONTINUED OPERATION

Small Radius U-bends

To date, no domestic Model F steam generators, of which Seabrook has one of the shortest operating times, have experienced circumferential cracking in small radius U-bends. The thermally treated Inconel 600 tubing at Seabrook has improved resistance to cracking compared to the mill annealed tubing used at other plants. The stress relief, performed prior to service on the U-bends of tubes located in Rows 1 through 10, resulted in a further reduction in the potential for crack initiation.

Dented Locations

The design of the Seabrook steam generator tube supports has eliminated the potential for the denting as observed at plants with carbon steel support plates. The Seabrook tube supports are made of Type 405 stainless steel which will not corrode and form nonprotective magnetite as does carbon steel. The quatrefoil hole design, used at Supports 2 through 8, reduces the area of tube-to-support contact and allows greater flow past the tube-to-support gap, thereby minimizing buildup of corrosive deposits.

Each time the SGs are examined the analysts are required to report tube dents. Based on a sample comparison of preoperational and inservice inspection results, no growth of preoperational dents has been identified. Prior to operation, minor dents were introduced into the tubing by either tube handling or installation of the tubes into the steam generators.

The small size of the dents is demonstrated by having no probe restrictions at dent locations. The lack of any large dents, combined with both the relatively short period of operation (4 effective full power years) and the improved crack-resistant properties of thermally treated Inconel 600 tubing, result in the conclusion that the potential of developing circumferential cracks is an extremely low probability event. This conclusion was further demonstrated by an EPRI Appendix H qualified rotating probe test performed on 12 dented locations during RFO 2 and RFO 3. The tests confirmed that cracks were not present at dented locations.

Based on tubing material properties, inner row U-bend stress relief, previous Seabrook inspection results, and the excellent performance of thermally treated Inconel 600 tubing in domestic Model F plants, continued operation of the Seabrook steam generators during Cycle 4 is justified.

5.0 FUTURE STEAM GENERATOR INSPECTION PLANS

The next scheduled Seabrook steam generator inspection is to occur during Refueling Outage 4, currently planned for November 1995. The NDE workscope will include a bobbin coil examination of a 40 percent sample of the tubes (minimum) in two steam generators (SGA and SGD) for determination of the overall condition of the steam generators. In addition, a sample of tubes will be inspected using a probe qualified for circumferential crack detection per Appendix H of the EPRI Steam Generator Examination Guidelines. The sample of tubes inspected for cracking will include:

1. The roll transition of 500 tubes in each of the two steam generators being examined.

2. The U-bends of 20 percent of the Row 1 tubes in each of the two steam generators being examined.

Should circumferential cracking be identified in the roll transition region, the planned expansion sample would include 100 percent of the tubes located in the sludge pile region and 20 percent of the tubes located outside of the sludge pile region in all four steam generators. If circumferential cracking outside of the sludge pile region was also observed in one or more tubes, then 100 percent of all tubes in all four steam generators would be examined for circumferential cracking using qualified techniques.

Should circumferential cracking be identified in the Row 1 U-bend region, 100 percent of the U-bends in Row 1 and Row 2 of all four steam generators would be examined for circumferential cracking using qualified techniques. U-bend inspections would continue until the region of cracking was bounded.

6.0 CONCLUSIONS

The Seabrook Model F steam generators contain thermally treated I600 tubing. This tubing is not as susceptible to cracking as is mill annealed I600 tubing. The fact that most other plants with Model F steam generators and thermally treated tubing have operated longer than Seabrook and have experienced no corrosion induced tubing degradation, substantiates the very low probability of corrosion first being observed at Seabrook. Previous rotating probe inspections of dent locations have demonstrated that cracking at dents has not occurred. Planned inspections during RFO 4 of the roll transition region of 1,000 tubes and a 20 percent sample of the U-bend region of Row 1 tubes using techniques qualified to Appendix H of the EPRI Steam Generator Examination Guidelines, will further demonstrate that circumferential cracks are not present in the Seabrook steam generator tubes.

7.0 ADDITIONAL QUESTION

On October 13, 1995 an additional question was asked by the NRC regarding the use of terrain plots in areas susceptible to circumferential cracking. Specifically, were terrain plots used to analyze rotating pancake coil (RPC) data during previous inspections and will terrain plots be used as part of the data analysis during the next steam generator tube inspection at Seabrook?

As previously stated, the steam generator tube regions most susceptible to circumferential cracking include: expansion transitions, small radius U-bends and dent locations. During previous examinations at Seabrook, no RPC data was acquired at expansion transitions and small radius U-bends. During RFO 2 and RFO 3, twelve dent locations were examined with RPC techniques, but use of terrain plots when performing analysis of RPC data was not required by the site-specific Steam Generator Eddy Current Data Analysis Guidelines. Reanalysis of these twelve dent locations is not justified based on the nature of the dents and lack of susceptibility to circumferential cracking as stated in Sections 3.0 and 4.0 above.

Following the issuance of NRC Information Notice 94-88, the Seabrook Steam Generator Eddy Current Data Analysis Guidelines manual was modified to include a requirement that the analyst review terrain plots for all rotating probe data collected. This practice will be used during Refueling Outage 4, currently planned for November 1995.