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Subject: Response to NRC Request for Additional Information Regarding the Toledo Edison Response to Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes" (TAC No. M92238)

Ladies and Gentlemen:

On April 28, 1995, the U. S. Nuclear Regulatory Commission issued Generic Letter (GL) 95-03, "Circumferential Cracking of Steam Generator Tubes," which requested steam generator tube information regarding the Davis-Besse Nuclear Power Station. Toledo Edison (TE) responded by letter dated June 23, 1995 (Serial Letter Number 2304). The NRC's letter dated December 13, 1995 (TE Log Number 4656) requested additional information and contained an enclosure with eight questions. The additional information requested is provided in the attachment to this letter.

Should you have any questions or require additional information, please contact Mr. James L. Freels, Manager - Regulatory Affairs, at (419) 249-2366.

Very truly yours,

FWK/llh

Attachment

cc: L. L. Gundrum, DB-1 NRC/NRR Project Manager
H. J. Miller, Regional Administrator, NRC Region III
S. Stasek, DB-1 NRC Senior Resident Inspector
Utility Radiological Safety Board

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QUESTION 1:

Discuss the design differences between the Davis-Besse steam generators and the generic design information provided in the B&W Owners Group response, if any.

RESPONSE TO QUESTION 1:

The Babcock and Wilcox Owners Group (BWOG) generic response said a Once-Through Steam Generator (OTSG) typically has 15,531 tubes. The Davis-Besse Nuclear Power Station (DBNPS) OTSGs have 15,457 tubes each.

The BWOG generic response stated that the Tube Support Plates (TSPs) have broached holes. All TSPs in the DBNPS OTSGs have broached holes except the 15th TSP which has both broached and drilled holes. In the DBNPS OTSGs, 1,621 of the 15,457 tubes have drilled holes at the 15th TSP. The drilled holes are located around the periphery.

The BWOG generic response said the steam temperature is about 570 degrees Fahrenheit. The DBNPS steam temperature is approximately 591 degrees Fahrenheit.

QUESTION 2:

Dented Regions including dented tube support plates:

Electric Power Research Institute (EPRI) report NP-6201 "PWR Steam Generator Examination Guidelines: Revision 3," dated November 1992, indicated that B&W plants have experienced denting at tube support plates and in the lower tubesheet. Circumferential indications have been observed at dented areas in recirculating steam generators. If denting has been observed at Davis-Besse and it is in a location potentially susceptible to circumferential cracking, please submit the information requested in Generic Letter (GL) 95-03 per the guidance contained in the GL. If a voltage threshold is used for determining the threshold for examining dents, provide the calibration procedure used (e.g., 2.75 volts on 4-20% through-wall ASME holes at 550/130 mix).

EPRI report NP-6201 indicates that the fifteenth tube support plate contains both broached holes and drilled holes. The drilled holes being prone to denting. Please clarify whether all of the tube support plates are of the broached hole designs or whether a number of them contain drilled holes. Discuss whether denting has been limited to the drilled hole locations, if applicable, or if it has been observed at other support plate intersections (i.e., broached holes).

RESPONSE TO QUESTION 2:

The DBNPS does consider "dings," regardless of their location in the OTSG, to be potentially susceptible to circumferential cracking. The information requested in the Generic Letter is provided below:

1) Evaluate recent operating experience with respect to the detection and sizing of circumferential indications to determine the applicability to their plant.

   "Dings" are considered to be potentially susceptible to circumferential cracking because of the associated increase in stress levels within the tubing. Note that tube diameter reductions in OTSGs are generally called "dings." The term "ding" has been used to distinguish them from the more severe classical denting observed in recirculating steam generators. Dings in OTSGs are most prevalent at the secondary face of the Upper Tubesheet (UTS) and Lower Tubesheet (LTS). Although not as common, dings have been detected at Tube Support Plates (TSP) and freespan locations also. Outside diameter degradation has been detected at dings in OTSGs.

   The region of the OTSG from the 14th TSP and above is where dings would be most susceptible to circumferential cracking. This region would be most susceptible because the tubes are at the highest temperature there. The steam temperature in this region is a minimum of approximately 590 degrees Fahrenheit and the reactor coolant temperature is a minimum of approximately 605 degrees Fahrenheit.

2) On the basis of the evaluation in Item (1) above, past inspection scope and results, susceptibility to circumferential cracking, threshold of detection, expected or inferred crack growth rates, and other relevant factors, develop a safety assessment justifying continued operation until the next scheduled steam generator tube inspections are performed.

   The DBNPS has a relatively small number of dings spread throughout the OTSGs. The current number of dings reported in in-service tubes and their location are as follows:

   SG 1

1) 14th TSP and above	11
2) TSPs 1 through 13	20
3) Spans 1 through 13	78
4) LTS secondary face	0
5) LTS	13
Total	122

   SG 2

1) 14th TSP and above	15
2) TSPs 1 through 13	1
3) Spans 1 through 13	9
4) LTS secondary face	82
5) LTS	12
Total	119

A limited number of dings in the region most susceptible to circumferential cracking were examined with 3-coil Motorized Rotating Pancake Coil (MRPC) probes during the last steam generator tube inspection. No circumferential indications were identified.

The area of greatest concern for OTSG tube dings at the DBNPS has been the freespan of the periphery tubes in the region of the abandoned and secured internal auxiliary feedwater header. This header is located in the span between the 15th TSP and the upper tube sheet secondary face. The dings were caused by loose parts (dowel pins, subsequently retrieved) contacting the tubes and from contact by the header itself. This event occurred in 1981. Damaged tubes in this area have been plugged or sleeved and, therefore, are not included in the data above.

The DBNPS OTSGs have dings on a small fraction of the inservice tubes. Of these, a small number are in locations that may make them more susceptible to cracking. As previously stated, 3-coil MRPC examinations of a limited number of dings in the most susceptible region for circumferential cracking during the previous steam generator inspection found no circumferential indications. This indicates that circumferential cracking has not developed as a result of dings present in the DBNPS OTSGs.

Continued operation until the next refueling outage, currently scheduled for April, 1996, is justified by the good performance of the DBNPS OTSGs. This good performance is shown by the low Reactor Coolant System leakage, typically less than 0.1 GPD. Continued operation is further justified by the relatively small fraction of dings in the DBNPS OTSGs and the absence of circumferential crack indications.

3) Develop plans for the next steam generator tube inspections as they pertain to the detection of circumferential cracking. The inspection plans should address, but not be limited to, scope (including sample expansion criteria, if applicable), methods, equipment, and criteria (including personnel training and qualification).

The next planned DBNPS steam generator inspection is scheduled for April/May 1996. The currently reported dings in the region at the 14th TSP and above will be examined. In addition, a 20% sample of the remaining currently reported dings will be examined from throughout the steam generators.

If circumferential crack-like eddy current indications are reported at a ding, an engineering evaluation would determine the need for inspection expansion. The evaluation would consider the physical parameters affecting the tubing. These parameters may include tube temperature at the ding location, heat of tube material, and ding location within the tube bundle. In addition, the evaluation would consider the results from supplemental examinations as well as the size and quantity of indications. For new dings reported during the next scheduled outage, an engineering evaluation would determine the need for supplemental examinations and the increased scope necessary to bound any potential problems. The same criteria as discussed above will be used in the engineering evaluation.

The technique for the detection of circumferential cracking at dings will use a probe which has been qualified for detection of circumferential cracks per Appendix H of EPRI Report NP-6201, "PWR Steam Generator Examination Guidelines: Revision 3." The analysts will be qualified to SNT-TC-1A Level II or higher, as well as to site-specific guidelines with respect to detection of circumferential cracking.

The DBNPS does not use a voltage threshold for performing supplemental examinations on dings.

As explained above in the response to Question 1, all TSPs in the DBNPS OTSGs have broached holes except the 15th TSP which has drilled holes instead of broached holes around the periphery. Of the tubes in-service with dings, none have occurred at drilled hole locations.

QUESTION 3:

Expansion transition examinations:

Clarify if the eight tubes that did not receive the post-roll stress relief are still in service.

Clarify the inspections performed during the last outage at the expansion transition region. Address the probe used and the number of tubes inspected.

Provide the criteria to be used for determining whether expansion of the inspections for expansion transition indications is necessary.

RESPONSE TO QUESTION 3:

The eight tubes which did not receive post-roll stress relief are still in service.

Although the standard 0.510" bobbin probe (as part of the required Technical Specification inspection) was used to examine expansion transitions (non-post-roll stress relieved and post-roll stress relieved) during the last outage (October/November 1994), no supplemental examinations were performed at expansion transitions.

If circumferential crack-like eddy current indications are reported at an expansion transition, the criteria to evaluate the need for inspection expansion will be developed by an engineering evaluation. The evaluation would consider the physical parameters affecting the tubing. These parameters may include tube loads, tube temperature, steam generator operating history, heat of tube material, and tube location within the tube bundle. In addition, the evaluation would consider the results from supplemental examinations as well as the size and quantity of indications.

QUESTION 4:

Lane/Wedge Region:

Clarify the inspection scope in the lane/wedge region during the last steam generator tube inspections (including the probe type and number (and/or percentage) of tubes inspected).

Provide the criteria to be used for determining whether the expanded inspection scope around any identified indications adjacent to the sleeved lane/wedge region is bounded.

RESPONSE TO QUESTION 4:

The DBNPS has installed preventive sleeves in the tubes in the lane/wedge region. The inspection scope of these sleeves during the last steam generator tube inspection (October/November 1994) was as follows:

In steam generator number 1, 13.6% of the previously installed in-service sleeves in the lane/wedge region had the three joints in the sleeve examined. The joints were examined with the "optimized" rotating cross wound probe. The examination revealed no indications. In steam generator number 2, preventive sleeving was installed in the lane/wedge region. The entire lane/wedge region was sleeved. All of the newly installed sleeves were examined with the cross wound/bobbin probe. No indications were reported.

If circumferential crack-like eddy current indications are reported in an unsleeved border tube, an engineering evaluation would determine the need for inspection scope expansion. The evaluation would consider the location of the tube within the region and the thermal/hydraulic conditions that the tube experiences. Tubes which experience similar thermal/hydraulic conditions in the lane/wedge region would be examined. A one tube wide border around the tubes with similar thermal/hydraulic conditions would be examined to assure bounding.

QUESTION 5:

Recently, several tubes have been pulled from B&W once through steam generators (OTSGs). Discuss any analyses performed on these pulled tubes for monitoring the development of circumferential cracking. For example, discuss the destructive and nondestructive examinations performed on these pulled tubes in the laboratory at the expansion transition area.

RESPONSE TO QUESTION 5:

Recent tube pulls from Crystal River 3 (1992 and 1994) and Oconee 3 (1994) have been performed to determine the cause of eddy current indications that were observed in areas of the steam generator where damage mechanisms are not well understood. These included both freespan indications and TSP indications, primarily in the boiling region of the OTSG. These indications did not have circumferential characteristics, therefore, specific analyses to monitor the development of circumferential cracking was not performed. The tubesheet expansion region was not an area of interest due to lack of observed degradation in this area. It was drilled out during the removal process to ease the removal of the rest of the tube. The tubesheet expansion area was therefore not available for laboratory examination.

QUESTION 6:

Clarify whether the inspection method to be used at Davis-Besse is qualified for the detection of circumferential cracks per Appendix H of Electric Power Research Institute (EPRI) report NP-6201 or whether a site specific qualification program will be used. If using site specific qualification procedures, state the differences and provide the justification for these criteria including a discussion of pulled tube data to support the detectability of circumferential cracks in the field.

RESPONSE TO QUESTION 6:

The examination of unsleeved areas of SG tubing believed to be susceptible to circumferential cracking will utilize probes currently listed as qualified for detection of circumferential cracking per the requirements of Appendix H of EPRI Report NP-6201.

No inspection technique is currently qualified per Appendix H for the detection of circumferential cracks in OTSG sleeves. Examination of sleeves during the Spring 1996 outage at the DBNPS will be conducted using a plus point probe, which Toledo Edison believes to be the best technique currently available for detection of circumferential cracking. This probe is currently qualified per Appendix H for detection of circumferential cracking in Westinghouse HEJ sleeves. Appendix H qualification for this technique for OTSG sleeves is currently being pursued in a project funded by the B&W Owners Group. This project is expected to result in successful qualification for detection of circumferential cracking per Appendix H by the end of 1996.

QUESTION 7:

Discuss the number and types of sleeves used at Davis-Besse along with their installation dates (i.e., month/year).

Clarify the extent of the inspections performed on these sleeved tubes during the last outage (e.g., 100% of all sleeve joints were examined with the "optimized" rotating cross wound probe).

RESPONSE TO QUESTION 7:

There are 212 80" BWNT Alloy 690 sleeves in-service in steam generator number 1. All 212 sleeves were installed in March/April 1993. 39 of these sleeves have minor scoring in unexpanded sections from installation tooling. There are 199 80" BWNT Alloy 690 sleeves in-service in steam generator number 2. All 199 were installed in October/November 1994.

The inspections performed during the last outage (October/November 1994) for steam generator number 1 were as follows:

62 of the 212 sleeves installed in steam generator number 1 were inspected using the bobbin cross wound probe in the unexpanded sections. Of these 62 sleeves, 31 (called sample set A in this letter) were also inspected using the optimized rotating cross wound probe in the expanded sections. The sample set A sleeves that received inspection by two different probes were part of the Technical Specification required sample.

39 of the 212 sleeves installed in steam generator number 1 received minor scoring in the unexpanded sections caused by tooling during installation. Eight of these sleeves with minor scoring were included in sample set A. The remaining 31 sleeves (called sample set B in this letter) were selected for the purpose of monitoring the minor installation tool marks.

Of the 62 sleeves inspected (sample sets A and B), one indication, in the upper roll, was identified in an installed sleeve of sample set A. A supplemental examination using a motorized rotating single coil pancake probe was performed. After examining the data, the indication was dispositioned as permeability.

The inspections performed during the last outage (October/November 1994) for steam generator number 2 were as follows:

All 199 sleeves were examined with the bobbin cross wound probe following installation. No indications were identified.

QUESTION 8:

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 (i.e., the next inspection per your Generic Letter 95-03 response).

RESPONSE TO QUESTION 8:

Non-rotating probes (i.e., bobbin) were the primary probes used for inspection in the majority of the areas of the DBNPS OTSGs during the last outage. The only pre-planned area identified as susceptible to circumferential cracking that was inspected last outage with rotating probes were sleeves. DBNPS Site Specific Analysis Guidelines require the use of terrain plots in addition to the Lissajous display when examining the areas of the sleeve roll expansions and sleeve ends when using the "optimized" rotating cross wound probe. A three coil MRPC was also used to examine a limited number of dings identified with the bobbin probe. Although not required by the analysis guidelines at the time, terrain plots were used for the evaluation of the dings to ensure detection enhancement.

The DBNPS will require through Analysis Guidelines that terrain plots be used when using any rotating probes in areas susceptible to circumferential cracking for any future inspections.