



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 28, 2011

Mr. Michael J. Pacilio
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 – SUMMARY OF
CONFERENCE CALLS WITH EXELON GENERATION COMPANY, LLC TO
DISCUSS 2011 STEAM GENERATOR TUBE INSPECTIONS
(TAC NO. ME7229)

Dear Mr. Pacilio:

On November 3, November 7, and November 11, 2011, the U.S. Nuclear Regulatory Commission (NRC) staff participated in conference calls with Exelon Generation Company, LLC personnel to discuss the steam generator inspection activities taking place at Three Mile Island, Unit 1 during the 2011 refueling outage. The calls were conducted in response to an NRC letter dated October 24, 2011, (Agencywide Documents Access and Management System Accession No. ML112790525). Enclosed is a summary of the conference calls, as prepared by the NRC staff.

Please contact me at 301-415-2833, if you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Peter Bamford".

Peter J. Bamford, Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure:
As stated

cc w/encl: Distribution via ListServ

SUMMARY OF CONFERENCE CALLS WITH
THREE MILE ISLAND NUCLEAR STATION UNIT 1
REGARDING THE FALL 2011 STEAM GENERATOR TUBE INSPECTION RESULTS
DOCKET NO. 50-289

On November 3, November 7, and November 9, 2011, the staff of the U.S. Nuclear Regulatory Commission (NRC) participated in a series of conference calls with representatives of Exelon Generation Co., LLC, (the licensee) regarding the ongoing steam generator (SG) tube inspection activities at Three Mile Island Nuclear Station Unit 1 (TMI-1).

TMI-1 has two ("A" and "B") enhanced once-through SGs (EOTSGs) manufactured by AREVA. The unit is on a 24 month fuel cycle. Each SG has 15,597 tubes made out of thermally treated Alloy 690. The tubes have a nominal outer diameter of 0.625 inches and a nominal wall thickness of 0.037 inches. The SGs contain fifteen stainless steel tube support plates (TSPs) that have broached tri-foil holes. The spacing between TSPs vary (as did the spacing in the original SG design). The broached tri-foil holes in each TSP have flat landings with chamfered edges (but do not have an "hour-glass" configuration). The tube-to-tubesheet joints were hydraulically expanded over the full depths of the upper and lower tubesheets. The SGs have the following design features to limit the potential for tie rod bowing: the diameters of the tie rods in the lowest span were increased, the tolerances around the TSP were adjusted, the design of the alignment pins was changed, and the tolerances associated with the filler plates were changed. No tubes were plugged prior to operation.

Summary of November 3, 2011, Teleconference

On November 3, 2011, NRC staff participated in a conference call with TMI-1 representatives regarding the results of the Fall 2011 outage SG tube inspections. At the time of the call, the licensee indicated the following:

- No primary to secondary leakage was indentified during the recently completed operating cycle and no secondary side pressure tests were performed during the outage. No exceptions to the industry SG guidelines were taken.
- One hundred percent of the tubes were scheduled to be inspected with a bobbin coil for the full tube length and all of the tubes in the SG periphery (two tubes deep) were scheduled to be inspected with an X-probe. The X-probe data was to be evaluated from the top of the lower tubesheet to the first TSP with the focus being on identifying potential loose part signals. Bobbin coil indications would be inspected with an X-probe. The licensee anticipated approximately 200 bobbin coil indications would need to be inspected with the X-probe.
- The only degradation found during the inspections was tube wear at the TSP elevations. The deepest indications noted were 27 percent in SG "A" and 28 percent in SG "B". There were 787 and 176 indications found out of approximately 13,000 and

Enclosure

2,000 tubes inspected for SGs "A" and "B", respectively. The indications were preferentially located near the second ring of tie rods (near the periphery) and most were at the 8th TSP.

- No proximity signals were identified. There was no evidence of the support plates being locked against the bundle wrapper. All tubes with flaws met the structural integrity performance criteria.
- No tubes were identified to require plugging (although a lower plugging/repair limit may be implemented) and there were no plans to perform in-situ testing or to remove tubes for destructive examination.
- No potential loose part signals had been identified at the time of the call. The licensee had no plans to perform secondary side inspections unless potential loose part signals were identified.
- The results of the tube inspections were as expected. The licensee noted that there was a higher than anticipated radiation level in SG "B" due to primary side contamination. The cause of the contamination was unknown and still being investigated. The licensee noted that water chemistry at TMI-1 was "normal" during the prior operating cycle and that this condition (elevated radiation levels) has been observed at other units. The licensee anticipated finishing the inspections in SG "A" within 48 hours and finishing the inspections in SG "B" by November 7th, but anticipated that the date for SG "B" may slip due to the high radiation levels noted.

The NRC staff did not identify any issues that warranted follow-up action at the time. However, the staff asked to be notified in the event that any in-situ pressure testing was performed or if any unusual conditions were detected during the remainder of the outage.

Summary of November 7, 2011, Teleconference

On November 7, 2011, NRC staff participated in a follow-up conference call with TMI-1 representatives for additional discussion regarding the results of the SG tube inspections. At the time of the follow-up call, tube inspections in SG "A" were 100 percent complete, and tube inspections in SG "B" were 76 percent complete. The licensee provided information that may be summarized as follows:

- In SG "A", approximately 952 wear indications at the TSP elevations were identified in 847 tubes, with the majority of these indications occurring in the region from the 7th to the 11th TSP. Additionally, inspections revealed approximately 79 indications of wear attributed to tube-to-tube contact in 64 tubes. These tube-to-tube wear indications ranged from 1 to 21 percent through-wall (TW), were predominantly between the 2nd and 3rd ring of tie-rods (when counting from the center of the SG), and were all located between the 8th and 9th TSP. Approximately 95 percent of the indications measured less than 15 percent TW.
- In SG "B", approximately 706 wear indications at the TSP elevations were identified in 618 tubes, with the majority of these indications occurring in the region from the 7th to

the 11th TSP. These indications ranged from 5 to 32 percent TW. Additionally, inspections revealed approximately 191 indications of wear attributed to tube-to-tube contact in 189 tubes. These tube-to-tube wear indications ranged from 1 - 20 percent TW based on bobbin coil data (no sizing of the indications with the rotating probe or X-probe data had been completed at the time of the call), were also predominantly between the 2nd and 3rd ring of tie-rods (when counting from the center of the SG), and most (182 indications) were located between the 8th and 9th TSP. Approximately 95 percent of the indications measured less than 15 percent TW. No X-probe inspections of these indications had been performed at the time of the call.

- The tube-to-tube wear is an unexpected degradation mechanism in the TMI-1SGs, which have operated for just one operating cycle. Most of the tube-to-tube wear involved two adjacent tubes contacting each other and wearing evenly, but there were a few instances of three tubes coming into contact and wearing.
- The licensee calculated repair limits for the tube-to-tube wear indications in accordance with the Electric Power Research Institute documents referenced in their SG Program (flaw handbook). The largest measured tube-to-tube wear scar was approximately 21 percent TW. The wear scars measured from 4 to 9 inches long and had a typical circumferential extent of about 50 to 60 degrees. In calculating the repair limit for the tubes, the licensee assumed a length of 40 inches and a circumferential extent of 135 degrees and used the equations for a flaw with limited axial and circumferential length. The repair limits were calculated by the licensee using both a deterministic and probabilistic approach. The repair limit was deterministically determined to be 33 percent TW (95 percent with 50 percent confidence). If a higher probability was used, the repair limit was 31 percent TW (99 percent probability with a 50 percent confidence). Depending on the growth rate used (maximum or 95th percentile), the limit varied from 33 percent to 36 percent TW when determined probabilistically for the whole bundle.
- The licensee stated that no loose parts had been found in either of the SGs and that there was no tube-to-tube contact (or tubes in close proximity) in the SGs when they were in the cold condition.
- The licensee noted that the only transient during the operating cycle was when the plant power output was lowered to 50 percent over a weekend.
- The licensee indicated that the shroud at TMI-1 is separated between the 9th and 10th TSP. There is limited access to the area of the tube bundle, where the tubes are exhibiting wear as a result of tube-to-tube contact, and there does not appear to be any connection between the tube-to-tube indications and the tie rod bowing issue observed at another facility.
- The licensee also indicated that the tubes are in compression during operations (hot conditions) and that the gap between the tubes is 1/8 inches.

- This issue has been entered into the corrective action process for both the licensee and AREVA, but the licensee stated that the results of the root cause investigation are not expected in the near term.
- The licensee indicated that they were evaluating whether they would be able to skip inspecting during the next refueling outage.

Summary of November 9, 2011, Teleconference

On November 9, 2011, NRC staff participated in a follow-up conference call with TMI-1 representatives for additional discussion regarding the results of the SG tube inspections. At the time of the call, the SG tube inspections were complete in both SGs.

- The licensee stated that all tubes in both SGs met the structural and leakage integrity performance criteria and that no in-situ pressure testing had been performed or was planned.
- In SG "A", approximately 952 wear indications at the TSP elevations were identified in 847 tubes. The depths of the wear indications ranged from 5 to 27 percent of the tube wall thickness, with the majority of indications occurring at the 8th TSP. Most of the indications had depths less than 20 percent of the wall thickness. Additionally, inspections revealed approximately 79 indications of wear attributed to tube-to-tube contact in 64 tubes. The depths of the wear indications ranged from 1 to 21 percent TW, the lengths ranged from 4 to 9 inches long, they were all located in the span between the 8th and 9th TSPs, and they were predominantly between the 2nd and 3rd ring of TSP tie-rods (when counting from the center of the SG). In the cold condition (i.e., plant shut down), there were no proximity signals identified, indicating that the tube-to-tube wear was occurring when the plant was operating.
- In SG "B", approximately 1342 wear indications at the TSP elevations were identified in 1035 tubes. The depths of the wear indications ranged from 5 to 52 percent TW, with nine tubes having indications exceeding the 40 percent TW plugging limit. The largest indications were located in tubes near the periphery of the SG bundle and at the 11th and 12th TSPs, while most of the smaller indications occurred at the 8th TSP.
- The licensee calculated a 30 percent TW whole bundle repair limit for the TSP wear indications. This repair limit will result in the stabilization and plugging of approximately 30 tubes in SG B.
- Additionally, inspections in SG "B" revealed 206 indications of wear attributed to tube-to-tube contact in 183 tubes. The depths of the wear indications ranged from 3 to 19 percent TW, the lengths ranged from 4 to 9 inches, the majority of these were located in the span between the 8th and 9th TSPs, and they were predominantly between the 2nd and 3rd ring of TSP tie-rods (when counting from the center of the SG). In the cold condition (i.e., plant shut down), there were no proximity signals identified, indicating that the tube-to-tube wear was occurring when the plant was operating.

- The licensee calculated a 33 percent TW whole bundle repair limit for the tube-to-tube wear indications, but decided to plug tubes with indications whose depths were greater than or equal to 15 percent TW. This repair limit was based on one cycle of operation. This will result in the stabilization and plugging of four tubes in SG "A" and three tubes in SG "B".
- A root cause analysis is being performed by AREVA and is focusing on the following areas: tube axial tension preloading, flow induced vibration as a result of the aspirator port location at the 10th TSP, and the potential for tube-to-tube gaps during operation being less than designed. A potential cause of the wear indications is higher than normal compression forces on the tubes combined with secondary side flow conditions and associated random turbulence. The preliminary results indicate that one cycle of operation does not pose a significant safety issue.
- The wear indications attributed to tube-to-tube contact were sized with amplitude-based sizing techniques. The bobbin, rotating probe, and/or X-probe were used to size the indications. The size estimates from the rotating probe and X-probe in SG "A" were nearly identical. The rotating and X-probe results from SG "A" were then used to justify a sizing technique for the X-probe, and the X-probe inspection technique was then used to size the indications in SG "B". The licensee stated that a flat wear scar sample set was used for the X-probe qualification, with a wear scar length that exceeded the coil spacing on the X-probe.

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