March 20, 2006

Mr. Christopher M. Crane
President and Chief Executive Officer
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SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 - REVIEW OF STEAM GENERATOR TUBE INSPECTION REPORT FOR FALL 2003 (1R15) OUTAGE (TAC NO. MC4619)

Dear Mr. Crane:

By letter dated February 24, 2004, as supplemented by letter dated September 27, 2005 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML042930336 and ML052720470, respectively), AmerGen Energy Company (the licensee) submitted the 2003 steam generator (SG) tube inservice inspection report for Three Mile Island Nuclear Station Unit No. 1 (TMI-1) in accordance with the plant technical specifications (TSs). This report, in part, described the licensee's SG inspection activities during the fall 2003 refueling outage (1R15).

The Nuclear Regulatory Commission (NRC) staff has completed its review of the licensee's submittals. The staff's review of the TMI-1 2003 SG tube inspection report is enclosed. The staff finds that the licensee has provided the information required by the TSs. As enumerated in the enclosed review summary, the NRC staff did identify some issues concerning the licensee's condition monitoring assessment. These issues have been discussed with the licensee, and it is the NRC staff's understanding that the licensee plans to address these issues in its 90-day report documenting the results of the fall 2005 (1R16) inspections.

If you have any questions regarding this matter, please contact me at (301) 415-1447.

Sincerely,

/RA/

Farideh E. Saba, Project Manager
Plant Licensing Branch I-2
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Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure:
As stated

cc w/encl: See next page

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REVIEW OF THREE MILE ISLAND NUCLEAR STATION, UNIT NO. 1

2003 STEAM GENERATOR TUBE INSPECTION REPORT

On February 24, 2004, AmerGen Energy Company (the licensee) submitted the 2003 steam generator (SG) tube inservice inspection report (Agencywide Documents Access and Management System (ADAMS) accession number ML042930336) for Three Mile Island Nuclear Station, Unit No. 1 (TMI-1) in accordance with the plant Technical Specifications (TSs). This report, in part, described the licensee's SG inspection activities during the fall 2003 refueling outage (1R15). The Nuclear Regulatory Commission (NRC) staff reviewed Attachment 1 to Enclosure 1 of the licensee's submittal, Topical Report Number 181, "Report on the 2003 Outage 1R15 Eddy Current Examinations of the TMI-1 OTSG [once-through steam generators] Tubing."

TMI-1 has two Babcock & Wilcox (B&W) OTSGs. These SGs have mill annealed Alloy 600 tubes. A unique feature of the TMI-1 OTSGs are the kinetic expansion repairs in the upper tubesheet of all inservice tubes performed in the early 1980s to address inner diameter (ID) intergranular attack (IGA) which is widespread at TMI-1.

Inspection Scope and Methods

The TMI-1 TSs define a tube inspection as extending from the bottom of the upper tubesheet to the top of the lower tubesheet. The inspection scope during 1R15 exceeded this minimum requirement. The general purpose bobbin probe inspection extended from the kinetic expansion transition in the upper tubesheet to the roll expansion transition in the lower tubesheet for all inservice tubes. In addition, bobbin probe inspections were performed for a 33% sample of sleeves in the unexpanded portions.

In addition to bobbin probe examinations, motorized rotating pancake coil (MRPC) probes were used to inspect various locations in the OTSGs including:

- The kinetic expansion inspection zone of 34% of the unsleeved, unplugged tubes with 17-inch kinetic expansions;
- 100% of the unsleeved, unplugged tubes with 22-inch kinetic expansions;
- All tubes at locations where the bobbin detected ID IGA indications below the kinetic expansion regions;
- Any other bobbin indications of possible tube wall degradation;
- All bobbin coil dents above the lower tubesheet secondary face;
- Approximately 33% of the tubes in the lower tubesheet kidney region from 5 inches above the secondary face of the lower tubesheet to 4 inches below the secondary face (this region was identified during refueling outage 14 (1R14) to include areas with lower tubesheet secondary face dents);
- 33% of the dents at the lower tubesheet secondary face outside the kidney zone; and
- A 59% and 100% sample in OTSG A and B, respectively, of the lower tube ends from the lower tube end through the lower tube end roll expansion transitions.

Further, +Point® coils were used to inspect the expansion regions of all sleeves.

Inspection Results - Kinetic Expansions

Thirty-four percent of unsleeved, unplugged tubes with 17-inch kinetic expansions and 100% of the unsleeved, unplugged tubes with 22-inch kinetic expansions were examined by MRPC. The inspection distance included the kinetic expansion transition and a length above the top of the expansion transition as necessary to establish that a "required" minimum defect-free axial length exists above the top of the transition. The specified defect-free length above the top of the expansion transition varies from 2.1 to 3.4 inches for the 17-inch kinetic expansions, depending on the radius of the tube from the center of the bundle and from 3.2 to 8.4 inches for the 22-inch kinetic expansions. The specified defect-free length and acceptance criteria for any flaws found in the kinetic expansion region for 1R15 were defined in licensee report ECR 02-01121, Revision 0 which was submitted by the licensee to the NRC by letter dated October 04, 2002 (ADAMS Accession Number ML022840503). Revision 0 of this report is similar to Revision 2 which was reviewed and approved by the staff on November 8, 2005 (ADAMS Accession No. ML052840138). Revision 2 of this report was submitted by letter dated October 14, 2005 (ADAMS Accession No. ML052940347).

The 34% inspection sample for the 17-inch kinetic expansions consisted of preselected 1st, 2nd, and 3rd inspection samples exceeding minimum TS sample size requirements when inspection results from these samples are Category C-1 and C-2, as defined in the TSs. The inspection results for each sample for each OTSG fell into either the C-1 or C-2 categories.

A total of four tubes failed to meet the specified structural acceptance criteria in ECR 02-01121, Revision 0, and were plugged.

Based on the methodology and criteria in ECR 02-01121, Revision 0, the licensee reported that a total of 88 indications were found in the kinetic expansions which could contribute to leakage during a main steamline break (MSLB). The licensee noted that all kinetic expansions have been inspected over the last three outages including 1R15, and that all tubes with indications found during previous inspections that could contribute to leakage during an MSLB were included in the inspection sample during 1R15. The licensee further noted that the ID IGA in the kinetic expansions is not growing; thus, indications found during refueling outage 13 and 1R14 that were determined not to be leakage contributors can be assumed to be in the same condition. This "no growth" observation is supported by licensee observations that ID IGA below the kinetic expansions are also not growing (based on the sign test and paired t-test, as discussed below). The calculated MSLB leak rate contribution from the "as found" condition of the kinetic expansions (i.e., condition monitoring) and the "as left" condition (i.e., operational assessment) were negligible relative to the acceptance limits based on leakage values assumed in the licensing basis accident analysis.

Inspection Results - ID IGA in Unexpanded Portion of OTSG Tubing

The ID IGA indications in the unexpanded portion of the tubing were dispositioned in accordance with the TMI-1 TS repair criteria which specifically addresses this mechanism. The axial and circumferential extent of all ID IGA indications were measured. In addition, ID IGA indications with sufficient bobbin coil signal-to-noise ratio and bobbin voltage were also given a percent through-wall estimate. All ID IGA indications exceeding the TS repair limits (i.e., axial and circumferential extent and percent through-wall) were removed from service by plugging. For 1R15, this amounted to three tubes, each of which contained indications which slightly

exceeded the 0.25-inch axial length criterion. The licensee reviewed the previous eddy current data for these indications and concluded they had not changed and that the differences in measured length were due to eddy current variability.

The axial and circumferential repair limits in the TSs is based on a "no growth" assumption (i.e., the ID IGA indications are not growing and, therefore, no allowance for growth was considered in the development of the repair limits). The licensee is required to perform two different statistical tests (i.e., a sign test and paired t-test) on three different eddy current indication parameters (i.e., bobbin coil estimated depth, bobbin coil voltage response, and circumferential extent as measured by rotating coil) every outage to monitor the no growth assumption. If all of these tests are passed, then the no growth assumption is considered valid and can be applied in the operational assessment. If any of these tests are unsuccessful, a cycle-specific growth rate model must be developed and approved by the NRC to be used for the operational assessment.

For 1R15, the licensee performed the required statistical tests and determined that all parameters passed the test criteria, which supports the no growth assumption. Details of statistical tests are documented in Section 3.B.1 of TR-181.

The licensee also evaluated the MSLB leakage associated with the ID IGA indications using the methodology in AmerGen Engineering Report, ECR No. TM 01-00328 which is referenced in the TMI-1 TSs. This evaluation relied, in part, on in-situ leakage testing conducted during the previous inspection (69 tubes were in-situ leakage tested with no leakage identified). No additional in-situ leakage tests were conducted during 1R15. The NRC staff notes that this is justifiable on grounds that the ID IGA flaws have been confirmed not to have grown since the previous inspection. The calculated MSLB leakage for the as found ID IGA indications was again very small, 0.047 gpm for OTSG A, and 0.006 gpm for OTSG B.

Inspection Results - Lower Tube Ends

In response to the finding of tube end cracks in the tube expansion zone in the lower tubesheet in OTSGs at another plant, the licensee performed an initial 20% MRPC sample during 1R15 for both TMI-1 OTSGs. These examinations extended from the lower tube end through the expansion transition and were concentrated in a peripheral ring extending radially inward beyond the most inward indication found at the other plant. In addition, another ring 20% radially further into the tube bundle was included as a buffer zone. Based on the initial inspection results, the inspections were expanded to include 100% of the tubes in the initial rings including the initial buffer zone and a new buffer zone 20% further inward, in accordance with the Electric Power Research Institute examination guidelines. In OTSG A, no indications were found in the buffer zone (including the initial buffer zone) and the examinations were considered complete at this point. This amounted to a 59% sample in OTSG A which satisfied TS sampling requirements since the inspection results category was C-2. In OTSG B, indications were found in the initial buffer zone, so the inspection was expanded to a 100% sample.

Based on the eddy current phase angle responses, all "tube end" indications were dispositioned as ID initiated degradation. The degradation included axial cracks (72 indications total) which were located in the lowermost 0.5 inches of the approximately 1-inch long expansion zone. The

affected tubes were plugged. In addition, approximately 170 volumetric indications were noted, all except one occurring in OTSG B. The axial locations of these volumetric indications ranged generally from near the tube end in the expansion zone to about an inch above the expansion zone, with two volumetric indications located 3 to 4 inches above the expansion zone. The licensee attributes these volumetric indications to ID IGA due to residual sodium thiosulfate damage similar to that at other locations of both OTSGs. The licensee states that all tubes with volumetric indications located within 2.5 inches of the tube end were plugged.

Condition monitoring methodologies for the indications found in the lower tubesheet were described in the licensee's letter dated September 27, 2005. This letter states that the condition monitoring analyses for structural integrity were based, in part, on an MSLB axial tensile load of 1340 lb-force (lbf). The NRC staff believes this assumption is appropriate for assessing MSLB leakage (as approved by the staff in the context of the flaw acceptance criteria for kinetic expansions), but is not appropriate for assessing structural integrity under MSLB conditions. Acceptance criteria approved by the NRC staff with respect to ID IGA on circumferential components in the kinetic expansion and in the unexpanded tubing is based on an assumed MSLB axial load of 3140 lbs. During a phone call with the NRC staff on November 7, 2005, to discuss the inspection findings from the 1R16 (fall 2005) outage, the licensee indicated that it would assume an axial load of 3140 lbs in its condition monitoring analyses from this time forth. The licensee stated that the 90-day report of the 1R16 inspections would confirm the use of this load.

The licensee is using the leakage model for the tube end cracking (TEC) alternate repair criteria approved by the NRC for other plants to assess MSLB leakage for both tube end cracks and ID IGA flaws in the tube expansion in the lower tubesheet. The licensee's leakage model departs from that which has been approved by the NRC (for other plants) in that only crack indications with a 2-volt response are assumed to leak rather than assuming that all indications leak, as is the case with the approved model. The NRC staff pointed out this discrepancy to the licensee by follow-up phone call with the licensee on November 8, 2005. The staff also stated during the November 8 call that the kinetic expansion leakage model for ID IGA indications was more appropriate for the ID IGA indications in the lower tubesheet expansion zone than the TEC leakage model. Additionally, the NRC staff pointed out that the assumed 80% depth threshold for assuming that ID IGA flaws will leak should be revised to be consistent with the assumed 67% threshold for leakage that the NRC staff approved as part of the kinetic expansion acceptance criteria. The licensee stated that they understood each of these comments and would evaluate the need to change their methodology.

Inspection Results - Wear Indications

Wear indications exhibited little change, on average, relative to the previous inspection. Maximum apparent growth did not exceed 8% through-wall. The licensee's report made no mention of any wear indications exceeding the 40% depth-based plugging limit.

Inspection Results - Other indications

Ten tubes were evaluated as having groove IGA, one tube with OD IGA, and two tubes with

possible loose part signals just above the 14th support plate. Each of these tubes was plugged and stabilized, including all remaining inservice tubes adjacent to the tubes with the possible loose parts indications.

Summary

As discussed above, the NRC staff identified several issues as a result of its review of the licensees 1R15 inspection results. These issues include: (1) the appropriateness of using an axial load of 1340 lbs rather than 3140 lbs when assessing structural integrity; (2) the use of a different leakage model for ID IGA flaws in the lower tubesheet expansion zone than is used in the kinetic expansion region; (3) the use of a different depth threshold at which point flaws are assumed to leak; and (4) assumptions on leakage from TEC. These issues were discussed with the licensee.