

May 10, 2007

Mr. Christopher M. Crane
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4300 Winfield Road
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SUBJECT: THREE MILE ISLAND NUCLEAR STATION UNIT 1 — REVIEW OF STEAM
GENERATOR TUBE INSPECTION REPORT FOR FALL 2006 OUTAGE
(TAC NO. MD0215)

Dear Mr. Crane:

By letter dated February 15, 2006, AmerGen Energy Company (the licensee) submitted the Cycle 16 Refueling (1R16) Inservice Inspection Summary Report for Three Mile Island Nuclear Station Unit 1. This report included as an attachment a report describing the results of the licensee's 1R16 steam generator (SG) inspection activities in Fall 2005. The SG inspection results were provided in accordance with Technical Specification 4.19.5.b. The licensee provided additional information concerning the SG inspection by letter dated August 29, 2006. In addition, information concerning these inspections was summarized by the Nuclear Regulatory Commission staff in a letter dated February 21, 2006.

We have completed our review of the licensee's submittals pertaining to the 1R16 SG inspections, and our review summary is enclosed. We find that the licensee has provided the information required by the technical specifications. We have identified an issue concerning sleeve inspections that is being evaluated by the staff as part of its review of License Amendment Request No. 331. Based on these considerations the subject TAC is being closed.

If you have any questions regarding this correspondence, please contact me.

Sincerely,

/ra/

Peter Bamford, Project Manager
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Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-289

Enclosure: As stated

cc w/encl: See next page

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THREE MILE ISLAND NUCLEAR STATION UNIT 1

REVIEW OF STEAM GENERATOR TUBE INSPECTION REPORT

FOR FALL 2006 (1R16) OUTAGE

By letter dated February 15, 2006 (ML060540412 [Agencywide Documents Access and Management System Accession Number]), AmerGen Energy Company (the licensee) submitted the Cycle 16 Refueling (1R16) Inservice Inspection (ISI) Summary Report for Three Mile Island Nuclear Station Unit 1 (TMI-1). This report included as an attachment a report describing the results of the licensee's 1R16 steam generator (SG) inspection activities in Fall 2005. The SG inspection results were provided in accordance with Technical Specification 4.19.5.b. The licensee provided additional information concerning the SG inspection by letter dated August 29, 2006 (ML062420464). In addition, information concerning these inspections was summarized by the Nuclear Regulatory Commission (NRC) staff in a letter dated February 21, 2006 (ML060270178).

TMI-1 has two Babcock & Wilcox (B&W)-designed once through steam generators (OTSGs). These steam generators 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.

The licensee's SG inspection report provided the scope, extent, methods, and results of their steam generator tube inspections as well as a summary of the licensee's condition monitoring assessment and operational assessment to support continued operation until the next scheduled inspection. The report also described corrective actions in the form of tube plugging and tube stabilization taken in response to the inspection findings.

As a result of its review of the licensee's inspection report for 1R16 and the additional information provided in the licensee's August 29, 2006 letter, the NRC staff has the following observations:

- All inservice tubes were inspected with a bobbin over the unexpanded portion of tubing. Special interest inspections were performed with a motorized rotating pancake coil (MRPC), which contains a +Point coil, a 0.115-inch pancake coil, and a 0.80-inch shielded high frequency pancake coil, at locations where bobbin identified various types of indications. These included all bobbin indications of possible tube wall degradation and a sample of dents as described later below. In addition, these included all tube locations with ID IGA indications ≥ 0.13 inches axial length or ≥ 0.25 inches circumferential length (these length criteria are equal to one half of the acceptance criteria for such flaws) in the unexpanded tubing and which were left in service following 1R15.
- Thirteen tubes were found to contain ID IGA flaws in the unexpanded portion of tubing exceeding the applicable acceptance criteria and were plugged and stabilized. This compares to three tubes exceeding the applicable acceptance criteria in 1R15. 747 tubes containing 1215 ID IGA indications were accepted for continued service in SG A and 36 tubes containing 43 ID IGA indications were

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accepted for continued service in SG B. For SG A, these numbers represent a notable increase compared to the numbers left in service in previous outages. Following 1R15, 529 tubes containing 961 ID IGA flaws were accepted for continued service in SG A. (During a telephone conference on November 28, 2006, the licensee attributed the increase in the number of ID IGA indications to the increase in MRPC scope compared to previous inspections.) The growth statistics for the bobbin depth and voltage measurements and for circumferential extent as measured by MRPC satisfied the applicable criteria (as referenced in the technical specifications) for verifying no growth of the ID IGA indications between inspections. (Although not a requirement, the licensee stated during a November 28, 2006 phone call that it also verified that the ID IGA flaws are not growing in axial extent using a similar statistical procedure.) The condition monitoring assessment indicated that the accident leakage contribution for ID IGA did not exceed 5 percent of the applicable acceptance criteria for total accident leakage.

- All kinetic expansions (KEs) in non-sleeved, inservice tubes were inspected with MRPC over the required inspection zone. New acceptance criteria, as approved by the NRC on November 8, 2005 (ML052840138), were implemented for the first time during 1R16 leading to the plugging and stabilization of 104 tubes, including all 94 tubes with circumferential indications and five tubes with ID IGA indications which were not detected in 1997 when the KE region was first inspected with a rotating coil. Tubes containing about 2200 ID IGA flaws in the KE region remain in service. The licensee's growth analyses for both the circumferential indications (which were plugged) and ID IGA indications indicate essentially no growth since the previous inspection. The condition monitoring assessment indicated that the accident leakage contribution from flaws in the KE region did not exceed 15 percent of the applicable acceptance criteria for total accident leakage. This is significantly more than reported for 1R15, reflecting the use of a more conservative leakage calculation model as approved by the NRC (ML052840138).
- The initial planned MRPC inspection scope for dents located above the secondary face of the lower tubesheet was all dents with a bobbin coil response of 2.5 volts or greater. These inspections led to the finding of five axial, outer diameter stress corrosion crack (ODSCC) indications at dents with bobbin voltages ranging to as low as 2.67 volts. However, circumferential crack indications were found with a rotating coil in tube B72-67 near a 1.38-volt dent indication located at the secondary face of the upper tubesheet. This indication was found due to the use of the secondary face as a landmark to support rotating coil inspection of the kinetic expansion region. Based on this finding the licensee expanded the inspection scope for dents to include all dents one volt and above which are located at or above the 15th tube support plate (TSP). In addition, because B72-67 was located two tubes away from the non-tubed open lane, a five tube band adjacent to the open lane was inspected from 1-inch below the upper tubesheet secondary face to the KE expansion transition. The dent inspections revealed no additional crack indications. The inspection of the five tube band did not identify any further OD cracks, but did identify two tubes with ID circumferential indications at or above 3/4-inches above the secondary face of the tubesheet. All tubes with the above indications were plugged and stabilized.

Three of the above five tubes with ODSCC and one of the two tubes with ID circumferential indications were in-situ pressure tested to three times normal operating pressure without burst or leakage.

At the staff's request, the licensee provided its justification for the expanded inspection scope. The licensee attributed the driving force for the OD circumferential indications in tube B72-67 to denting or high steam velocity/cross-flow, so the licensee defined a critical area (as described above) intended to be consistent with both potential causal factors. That is, the expanded inspection scope extended to the next hottest location, i.e., the 15th TSP, relative to the secondary face of the upper tubesheet where the circumferential indications were found. In addition, the uppermost tubing span between the 15th TSP and the secondary face of the upper tubesheet is the location at which cross-flows through the tube bundle are at a maximum. The licensee also noted that the 2.5-volt dent screening criterion used for axial ODSCC outside the critical area is more conservative than the 5-volt criterion used at many plants. Finally, the licensee stated that industry guidance and the site-specific performance demonstration sensitized the data analysts to bobbin dent signals with a high phase angle which may be indicative of axial cracks. Such bobbin signals are recorded as a non-quantifiable indication (NQI) and a followup rotating coil inspection is performed to better characterize the indication. However, the staff has insufficient information to judge the likelihood that bobbin will identify an NQI in the event of an axial crack at a less than 2.5-volt dent.

The staff notes that there is only a weak relationship between dent bobbin voltage response and strain level within the dent. Since axial ODSCC has been observed at dents with voltages ranging to as low as 2.67 volts, the staff notes there is the potential for cracks to occur at dents with voltage responses less than 2.5 volts. The license states that the rotating coil examination scope for dents for the next scheduled inspection (1R17) has not been finalized.

The licensee did not provide justification for the expanded inspection scope in light of the two tubes found with ID circumferential indications. The staff notes that it is not unexpected, given TMI-1's history with ID IGA, that a first time inspection of a portion of tubing with MRPC has yielded the finding of previously unknown ID-IGA flaws, particularly those that are predominately circumferential. Much of the tubing at TMI-1 has not been inspected with MRPC, and it is not unlikely that additional ID IGA flaws are present in the TMI-1 SG tubing and remain undetected. The technical specification inspection requirements pertaining to ID IGA are based on the premises that such flaws will become detectable to bobbin before they become of tube integrity significance and that these flaws are not growing. Although ID circumferential indications might not be detectable to bobbin under any circumstance, the indications found during this inspection (by MRPC) were less than 0.22 inches in length and were not of tube integrity significance.

- Ten tubes were found with OD "groove IGA" indications. These were low voltage indications with both bobbin and MRPC, and all were plugged and stabilized.

- A 33 percent sample of the alloy 690 sleeves was inspected with bobbin. A 100 percent sample of the lower sleeve joints and a 33 percent sample of the upper sleeve joints were inspected with a rotating +Point coil. The +Point inspection of the lower sleeve joints included the parent tube at the joints, but +Point inspection of the upper sleeve joints did not include the parent tube. The staff will evaluate the technical justification for not inspecting the parent tube at the upper tube joint as part of its ongoing review of License Amendment Request No. 331 (ML061420294) or, alternatively, ensure that appropriate inspection or repair requirements pertaining to the sleeve upper joints are included as part of the license amendment.
- All lower tube ends received an MRPC inspection up through the expansion transition. These inspections led to the plugging of 14 and 34 tubes in SG A and SG B, respectively, mostly involving circumferential crack indications, but also involving ID IGA indications. All tubes with indications in the lower tube expansion region were plugged and stabilized.
- The licensee's condition monitoring and operational assessment of lower tube end indications for 1R16 considered an axial main steam line break (MSLB) load of 3140 pounds for assessing tube structural integrity. This satisfactorily addresses a staff concern identified in the staff's review (ML060180620) of the licensee's inspection report for 1R15 performed in 2003.
- The licensee's condition monitoring and operational assessment of volumetric indications at the lower tube ends (attributed to ID IGA) for 1R16 considered a flaw depth threshold of 67 percent through wall above which the flaw was assumed to leak under MSLB conditions. This satisfactorily addresses a staff concern identified in the staff's review (ML060180620) of the licensee's inspection report for 1R15 performed in 2003.
- The licensee's condition monitoring and operational assessment of crack indications at the lower tube ends for 1R16 continued to consider a 2-volt threshold beyond which the cracks were assumed to leak. As stated in the staff's review of the 1R15 inspection (ML060180620), the licensee used the leakage model for the tube end cracking (TEC) alternate repair criteria (ARC) approved by the NRC for other plants to assess MSLB leakage for tube end cracks in the tube expansion in the lower tubesheet. The licensee's leakage model departed from that which has been approved by the NRC (for other plants) in that only crack indications with a 2-volt response were assumed to leak rather than assuming that all indications leak as is the case with the approved model. The licensee states that the 2-volt threshold criterion was retained in order to be consistent with industry guidance. The staff does not have a basis to judge the conservatism of the licensee's approach. Irrespective of whether the licensee's approach is conservative, it is the staff's judgement that the level of crack activity in this region is not such as to create concerns that such cracks could contribute significant accident induced leakage.
- Apart from accident leakage associated with indications in the KE region and that associated with the ID IGA flaws, the licensee did not report its specific estimates of accident leakage contributions associated with other degradation mechanisms at TMI-1, nor do the technical specifications require such a report for these other

mechanisms. However, the staff's review of the overall inspection results for 1R16 raised no concerns regarding total potential accident induced leakage (i.e., from all degradation sources) relative to applicable licensing basis limits.

Based on a review of the information provided, the staff concludes that the licensee provided the information required by their technical specifications. The staff will evaluate the technical justification for not inspecting the parent tube at the upper sleeve tube joints as part of its ongoing review of License Amendment Request No. 331 or, alternatively, ensure that appropriate inspection or repair requirements pertaining to the sleeve upper joints are included as part of the license amendment. The staff has identified no other issues that warrant followup action at this time.