AmerGen Energy Company, LLC
200 Exelon Way
Kennett Square, PA 19348

www.exeloncorp.com

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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Three Mile Island, Unit I (TMI Unit 1)
Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Additional Information – Cycle 16 Refueling Outage Steam Generator Inspection Summary Report

Reference: 1) AmerGen Energy Company, LLC letter to NRC, dated February 15, 2006 (5928-06-20368), "Cycle 16 Refueling (T1R16) Inservice Inspection (ISI) Summary Report."

This letter provides additional information in response to an NRC request for additional information received via NRC email, dated July 3, 2006, regarding the TMI Unit 1 Cycle 16 Refueling Outage Once-Through Steam Generator Inspection Summary Report submitted in Reference 1. The additional information is provided in Enclosure 1.

No new regulatory commitments are established by this submittal. If any additional information is needed, please contact David J. Distel at (610) 765-5517.

Respectfully,

Pamela B. Cowan
Director - Licensing & Regulatory Affairs
AmerGen Energy Company, LLC

Enclosure: 1) NRC Questions and AmerGen Responses

cc: S. J. Collins, USNRC, Administrator Region I
D. M. Kern, USNRC, Senior Resident Inspector, TMI Unit 1
F. E. Saba, USNRC, Project Manager, TMI Unit 1
File No. 02032

ENCLOSURE 1

NRC Questions and AmerGen Responses

Request For Additional Information
Related to TMI Unit 1 Cycle 16 Refueling Outage Steam Generator Inspection Summary Report

Reference: AmerGen letter dated February 15, 2006, Enclosure 1, Attachment 1, "Report on the 2005 Outage 1R16 Eddy Current Examinations of the TMI OTSG Tubing." (This reference is referred to below as the 90-day report.)

1. **NRC Question**

The initial planned rotating coil 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. After the finding of circumferential crack indications near a 1.38 volt dent in tube B72-67 at the secondary face of the upper tubesheet, this inspection scope was expanded to include dents 1 volt and above for dents located above the 15th support plate. However, OD axial indications were found below the 15th support at dents ranging to as little as 2.67 volts (tube B92-115). Strain at dents does not correlate strongly with voltage response and, in addition, dents exhibiting less than a 2.5 volt response can have higher strain than dents exhibiting greater than a 2.5 volt response. What is the basis for not inspecting dents below the 15th support plate exhibiting bobbin voltage responses less than 2.5 volts? Are there plans to sample dents located below the 15th support plate and exhibiting less than a 2.5 voltage response with a rotating coil at the next scheduled inspection?

Response

AmerGen agrees with the staff that strain at dents does not typically correlate well with their bobbin coil voltage response. For this reason, AmerGen performed additional inspections of TMI Unit 1 tubing after finding indications in Tube B72-67. These additional inspections were based on the indications' axial location, the B72-67 tube's radial location in the tube bundle, and the bobbin coil voltage of the nearby dent.

The indications in tube B72-67 were found at the secondary face of the upper tubesheet. Owing to the flaw location and profile (adjacent to a dent, near the open lane, near the secondary face of the tubesheet, outside-diameter initiated, and having a circumferential morphology) the flaw was considered to be Outside Diameter InterGranular Attack/Stress Corrosion Cracking (OD IGA/SCC). The driving force for this type of flaw at this location was attributed to denting or high steam velocity/crossflow; so two EPRI Guidelines critical areas were defined. One critical area included all un-sleeved inservice tubes near the open lane plus a required buffer zone, and the other critical area included low voltage dents and a buffer zone for dented regions in both steam generators. The dented region critical area included dents at the secondary faces of the upper tubesheets, and also included a vertical region that included a 100% sample of the dented areas at the next coldest elevation (i.e., the 15th tube support plate). This exceeded the 20% sample of the dented areas that would have been required per Table 3-5 of the EPRI *Steam Generator Examination Guidelines*.

Steam cross-flow velocities are considerably lower at the tube support plates (TSP) below the 15th support plate. The uppermost tubing span (between the 15th TSP and the secondary face) is the location at which cross-flows through the bundle are at a maximum since superheated steam is routed from the steam generator tube bundles within this uppermost span. A large number of additional dents at the secondary faces, and at the 15th tube support plate (TSP) beneath the secondary faces, were examined. No degradation at 1.00 to 2.50 Volt dents was identified at these relatively hot (and likely more susceptible) expanded scope locations.

The TMI Unit 1 bobbin coil Examination Technique Specification Sheet (ETSS) provides the following guidance for data analysis:

> *"...Dents may be prone to cracking and should be reviewed for possible degradation. Examples of this include dent signals which have rotated up or rotate up as frequency decreases and distorted signals with a vector or signal component in the ID or OD flaw plane. If in doubt, report as NQI."*

The site-specific performance demonstration (SSPD), which each eddy current analyst is required to complete prior to analyzing data for TMI Unit 1, includes bobbin indications with high phase angles, and the site training document also provides examples of dents with rotation. During the 1R16 Outage there were sixteen bobbin coil indications recorded as Non-Quantifiable Indications (NQI) that ranged from 140 degrees to 167 degrees (i.e., flaws outside the normal flaw rotation window that could be considered dent-like indications with rotation). Fifteen of these NQI indications ranged from 0.15 volts to 1.03 volts and were examined with MRPC probes with no indications of degradation identified at these locations. Tube A60-121 was the sixteenth tube in this population of high phase angle NQI indications. Tube A60-121 was identified with a 150 degree 5.24 volt bobbin NQI indication that was confirmed to have an OD axial indication at a dent. In addition to the above NQI indications, Tube B92-115 was recorded as a 158 degree 2.67 volt dent and had an axial OD indication identified at the dent. Tubes A60-121 and B92-115 were removed from service.

It should also be noted that many recirculating steam generator owners are applying a bobbin coil technique that is used to screen for axial ODSCC at dents <5 volts. TMI Unit 1 is applying a much more conservative approach for detecting axial ODSCC at dented locations because all dents ≥2.5 volts above the lower tubesheet, and all NQI indications regardless of voltage, are scheduled for MRPC examination each outage.

Based on the above 1R16 Outage practices, TMI Unit 1 applied a conservative approach to detection of degradation at dented locations that was in accordance with the TMI Unit 1 Technical Specifications and the EPRI *Steam Generator Examination Guidelines*. The examination scope for dents has not yet been finalized for the next scheduled inspection. Dent indications, and potential cracks at dented locations, will be addressed in the plant's degradation assessment. The next outage's scope will depend upon the degradation assessment created prior to the inspection, which, in turn, will depend upon future applicable industry experience and guidance.

2. **NRC Question**

Table 3-3 describes the scope of +Point inspections performed at the sleeve upper and lower two roll expansions. Please confirm that these inspections included inspection of the parent tube at each of these joints. If not, provide the technical basis by which the integrity of the sleeve to tube joints is ensured.

Response

The inspections did not include the parent tube at the sleeves' upper roll expansions, as was described in AmerGen's ECR #02-01121, Rev. 2, approved by the NRC in Safety Evaluation Report dated November 8, 2005, and as presented in the February 16, 2005 NRC/AmerGen meeting presentation slides. The sleeves' +Point inspection technique included the parent tubing at the lower sleeve roll expansions.

In summary, the integrity of the sleeve joints is ensured by:

- Performing periodic examinations of the sleeves. (For example, during the 1R16 Outage 33% of the sleeves were inspected by bobbin, 33% of the sleeves' upper expansions were inspected by +Point, and 100% of the sleeves' lower expansions, including parent tubing, were inspected by +Point.)

- Monitoring the steam generators for primary-to-secondary leakage during normal plant operation.

- The upper sleeve joints are expanded and remain captured well within the upper tubesheets. They are prevented from bursting and protected from potential secondary side loose parts, crossflows, and vibrations by the 24-inch thick tubesheet.

- The upper ends of the TMI Unit 1 sleeves were installed in expanded tubing that was repaired by a kinetic expansion process. Qualification testing for the sleeves included installation in expanded tubing.

- All of the TMI Unit 1 steam generator sleeves were manufactured from Inconel-690. This is a degradation-resistant material used for new steam generator tubes.

3. **NRC Question**

The staff's review of the Fall 2003 inspection at TMI-1 was provided by letter dated January 9, 2006 (Accession No. ML060180620). This letter and the enclosed review summary stated that the staff had identified some issues concerning the condition monitoring assessment conducted during the Fall 2003 inspection and that these issues had

been discussed with the licensee in phone calls dated November 7 and November 8, 2005. As stated in the letter, it was the staff's understanding that the licensee planned to address these issues in the 90-day report for the Fall 2005 outage. Our review of the 90-day report for the Fall 2005 steam generator inspection indicates that these issues are not addressed. The issues identified in the staff's January 9, 2006-letter include:

- Condition monitoring methodologies for the indications found in the lower tubesheet were described in the licensee's letter dated September 27, 2005 (ML052720470). This letter states that the condition monitoring analyses for structural integrity were based, in part, on an MSLB axial tensile load of 1340 lbf. The 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 circumferential components in the kinetic expansion and in the unexpanded tubing is based on an assumed MSLB axial load of 3140 lb. During a phone call with the 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 lb 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.

- During the Fall 2003 inspection, 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 both tube end cracks and ID IGA flaws 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 staff pointed out this discrepancy to the licensee by followup phone call with the licensee dated November 8, 2005. The staff also observed 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. Also, the staff pointed out 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 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.

We request that you address these issues as part of your response to this Request for Additional Information.

Response

It is noted that NRC has verbally confirmed that the January 9, 2006 correspondence referenced in the above question is an NRC internal staff review memorandum and was not issued to AmerGen. The correct reference is NRC letter to AmerGen, dated March 20, 2006, regarding the staff's review of the TMI Unit 1 Steam Generator Tube Inspection Report for Fall 2003 (1R15) Outage.

As discussed in the November 7 and 8, 2005 phone calls, 3140 lbs. axial load was assumed in the 1R16 Outage condition monitoring and operational assessment evaluations of structural integrity.

At TMI Unit 1 all lower tube end indications of tube degradation are removed from service, so we are not implementing a TEC ARC as is undertaken at some other plants. As discussed in the November 7 and 8, 2005 NRC phone calls, the 1R16 Outage evaluation methodology was revised to change the ID IGA 80% depth leakage threshold to a 67% threshold to be more consistent with the upper tubesheet. The 2.0 Volt leakage threshold criterion was retained for crack-like indications at the lower tube ends in order to be consistent with industry guidance.