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10 CFR 50
10 CFR 51
10 CFR 54

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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Three Mile Island Nuclear Station, Unit 1.
Facility Operating License No. DPR-50
NRC Docket No.50-289

Subject: Response to NRC Request for Additional Information related to Three Mile Island Nuclear Station, Unit 1, License Renewal Application.

Reference: Letter from Mr. Jay Robinson (USNRC), to Mr. Michael P. Gallagher (AmerGen) "Request for additional information for Boral Neutron Absorbing Material in Spent Fuel Pool Racks, Three Mile Island Nuclear Station, Unit 1, License Renewal Application", dated October 20, 2008. (TAC No. MD7701)

In the referenced letter, the NRC requested additional information related to Boral Neutron Absorbing Material in Spent Fuel Pool Racks, of the Three Mile Island Nuclear Station, Unit 1, License Renewal Application (LRA). Enclosed are the responses to this request for additional information.

This response resulted in a change to our commitments identified in Appendix A (A.5 commitment list), of the Three Mile Island Nuclear Station, Unit 1, License Renewal Application. These commitment changes are summarized within Enclosure B, Summary of Commitments.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

Executed on 11-12-2008

Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

A131
NRR

Enclosure A: Response to Request for Additional Information for Boral Neutron Absorbing Material in Spent Fuel Pool Racks, of the Three Mile Island Nuclear Station, Unit 1, License Renewal Application.

Enclosure B: Summary of Commitments

cc: Regional Administrator, USNRC Region I, w/Enclosure
USNRC Project Manager, NRR - License Renewal, Safety, w/Enclosure
USNRC Project Manager, NRR - License Renewal, Environmental, w/o Enclosure
USNRC Project Manager, NRR - TMIGS, w/o Enclosure
USNRC Senior Resident Inspector, TMIGS, w/o Enclosure

File No. 08001

Enclosure – A

Response to Request for Additional Information for Boral Neutron Absorbing Material in Spent Fuel Pool Racks, Unit 1, License Renewal Application.

Note: As a standard convention for AmerGen RAI responses, added text will be shown as ***bolded italics*** whereas deleted text will be shown as ~~strikethrough~~.

RAI#: 3.3.2.2.6-1 Reduction of Neutron-Absorbing Capacity and Loss of Material due to General Corrosion

The Generic Aging Lessons Learned (GALL) Report recognizes the possibility of the existence of aging effects in the Boral used in the spent fuel storage racks and the need for having a plant specific aging management program (AMP). However, in the Three Mile Island Nuclear Station Unit 1 (TMI-1) License Renewal Application (LRA), Amergen Energy Company, LLC, (the applicant) has indicated that degradation of Boral is insignificant and no AMP is required. The applicant provided several justifications for not having an AMP, but has stated that they will continue to implement a surveillance program.

In order to complete its review, the staff requests that the applicant provide a description of the surveillance program that will be implemented during the period of extended and include the following information in the response:

1. Provide the scope of the program, including the structures and components that will be under surveillance.

2. Describe how the neutron-absorbing capacity and degradation of material will be monitored, including a description of the parameters, calculations, and acceptance criteria.

3. Discuss how the structures and components will be maintained for the period of extended operation, including the methods, techniques (e.g., visual, weight, volumetric, surface inspection), frequency, sample size, data collection and timing.

4. Confirm that TMI-1 has sufficient Boral coupon samples to maintain the sampling frequency through the period of extended operation. Also include:

    a. The location of coupons relative to the spent fuel racks.

    b. The mounting of the coupons and whether or not they are fully exposed to the spent fuel pool water.

    c. The specific testing procedures used for determining Boral-10 areal density, verifying surface corrosion, (if any), and examining for blister formation.

    d. The location of the coupons after removal from the pool for inspection and reinsertion in the pool.

5. Describe how Boral will be monitored and trended.

6. Describe the acceptance criteria of the program and how it ensures that Boral's structure and function are maintained over the period of extended operation.

7. Describe the corrective actions that would be implemented if coupon test results are not acceptable.

8. In September 2003, inspection of Boral test coupons at Seabrook Nuclear Station revealed bulging and blistering of the aluminum cladding. Discuss the impact, if any, that this event is considered to have on the Boral surveillance program at TMI-1. Industry

experience has indicated that during longer exposure such blisters may form. Since formation of blisters may affect the efficiency of the Boral panels to attenuate neutrons (through flux trap formation) and may cause deformation of the fuel cells, explain why blistering will not be a safety concern.

9. Discuss any other operating experience of Boral that may be applicable to TMI-1 and describe why it will not be a safety concern.

10. Describe how the Water Chemistry program will be used to manage the loss of material due to general corrosion of Boral. Include the parameters that will be monitored, the parameters' acceptance criteria, and how they will effectively manage the loss of Boral.

AmerGen Response

1. The TMI-1 Boral test coupon surveillance program involves the periodic measurement of Boral test coupons to ensure against unexpected degradation of the neutron-absorbing Boral panels that are contained in the TMI-1 high density fuel storage rack assemblies.

2. Boral test coupon surveillance for TMI-1 consists of visual observations (which may include photography), dimensional measurements (length, width, and thickness), weight and density determinations, and neutron attenuation measurements (for B-10 areal density). Calculations are performed for determining coupon density by the immersion technique, and for B-10 areal density from neutron attenuation measurements. Acceptance criteria are a decrease of no more than 5% in Boron-10 content as determined by neutron attenuation measurements, and an increase in thickness at any point should not exceed 10% of the initial thickness. Changes in excess of either of these criteria require investigation and engineering evaluation as directed by TMI-1 Reactor Engineering.

3. The TMI-1 Boral test coupon surveillance program directs coupon testing in accordance with the spent fuel rack manufacturer's recommendations. The coupon is removed from the test coupon tree located in the spent fuel pool and is shipped to a contractor measurement laboratory. The measurement laboratory characterizes the test coupon in conformance with the rack manufacturer's procedure.

Inspection of the test coupon includes visual observation and photography, dimensional measurements, weight and density/specific gravity, and neutron attenuation. The coupon is visually examined to detect pitting, swelling, or other degradation. The coupon may be photographed if, in the judgment of the technician, there is any information of significance that should be photographically documented. Length and width of the coupon are measured at multiple locations (three each per coupon) for comparison to the original (pre-irradiated) dimensions. Thickness of the coupon is measured at multiple locations (five per coupon) for comparison to the original dimensions. Coupon weight and density/specific gravity are measured and calculated. Neutron attenuation is measured using a collimated thermal neutron beam. The counting intervals used are sufficient to assure the standard error due to counting statistics is essentially negligible (<0.15%) at the lowest counting rate.

After the high-density storage racks containing Boral absorber were first installed in 1992, a test coupon was removed and examined every two years. This continued for the first five cycles

following rack installation. A coupon will continue to be removed and examined every 5 years throughout the period of extended operation.

One coupon is removed for examination. Based on engineering evaluation of the test results of that coupon, additional coupons may be removed and examined to provide additional or corroborative information.

A report of the examination of each Boral surveillance coupon is prepared by the measurement laboratory and submitted to TMI-1 engineering. Results of the examinations are summarized in the report and tabulated on coupon measurement data forms contained in the report.

4. Two coupon sample trees are located in the TMI-1 spent fuel pool. A total of fourteen sample coupons remain. At the nominal rate of one coupon sampled every five years, a more than sufficient number of coupons remains to maintain the sampling frequency through the period of extended operation.

a. Upon installation in 1992 of the high density fuel storage racks containing the Boral absorber material, one coupon tree, intended for long-term testing, was located in the spent fuel pool in a manner such that it was surrounded by freshly discharged spent fuel assemblies. The second coupon tree was intended for accelerated exposure. This tree was located such that it was surrounded by hot, freshly discharged fuel for each of the first five cycles following installation of the racks containing Boral. This coupon tree has remained in the last location following the fifth cycle discharge. This sample location strategy meets the recommendations from the rack manufacturer.

b. The Boral sample coupons are encased in stainless steel jackets of an alloy identical to that used in the storage racks, formed so as to encase the Boral and fix it in position with tolerances similar to those for the storage racks. The Boral coupon specimens are fully exposed to the pool water, as are the Boral absorber panels in the vented storage racks.

c. The coupon is visually examined to detect pitting, swelling, or other degradation such as blistering. The coupon may be photographed if, in the judgment of the technician, there is any information of significance that should be photographically documented. Areal density is determined from neutron attenuation, which is measured using a collimated thermal neutron beam. The counting intervals used are sufficient to assure the standard error due to counting statistics is essentially negligible (<0.15%) at the lowest counting rate. A collimated beam of thermalized neutrons is passed through the sample in a perpendicular direction. The number of neutrons emerging is counted with a neutron detector. By comparing the counting rate for the surveillance sample with a corresponding rate from a standard sample, the relative transmission is determined.

d. To date, TMI-1 has not reinserted test coupons into the spent fuel pool following their removal and inspection.

5. Monitoring of the Boral neutron absorber is accomplished through periodic examination of the Boral test coupons, consisting of visual observations (which may include photography), dimensional measurements (length, width, and thickness), weight and density determinations, and neutron attenuation measurements (for B-10 areal density). Results are compared to archive values from pre-irradiated samples, and with results from previous coupon examinations, summarized in reports of the surveillance compiled by the measurement

laboratory and forwarded to TMI-1 Reactor Engineering for review. The results are evaluated against acceptance criteria for determination of any follow-up activities as appropriate (e.g., removal and examination of additional coupons, wet chemical analyses, radiography, etc.). The evaluation reports of the coupon examinations are maintained to provide a continuing source of data for trend analysis.

6. Acceptance criteria of the TMI-1 Boral surveillance program are as follows:

- A decrease of no more than 5% in Boron-10 content as determined by neutron attenuation measurements.
- An increase in thickness at any point should not exceed 10% of the initial thickness at that point.

The Boral test coupon surveillance program was established to monitor the integrity and performance of Boral on a continuing basis and to assure that any slowly developing or long-term effects, if any, do not become significant. The surveillance program is intended to detect the onset of any significant degradation with ample time to take corrective action as may be necessary.

7. Changes in excess of either of the acceptance criteria require investigation and engineering evaluation as directed by TMI-1 Reactor Engineering. Based on the results of the engineering evaluation, additional activities may be determined to be appropriate. These additional activities may include:

- Early retrieval and measurement of one or more of the remaining coupons to provide corroborative evidence that the measurements are real.
- Wet chemical analyses (destructive) and radiography (non-destructive) for confirming measurements.

If corroborated results of the test coupon surveillance program do not satisfy acceptance criteria, additional actions such as in situ radiography, or "blackness testing" of the spent fuel racks, may be employed to investigate the extent of degradation, if any, in the racks. In the event that any degradation of the Boral absorber in the spent fuel racks is detected, neutron radiographs of the suspected locations may be obtained. Positive confirmation of any defects will result in evaluations to assure that required subcriticality margin is maintained. Actions may include restrictions on rack cell use, repair of the cell to restore absorber effectiveness, or installation of new racks.

8. The Seabrook operating experience report and subsequent Part 21 notification concerning bulging and blistering of a Boral surveillance coupon has had no impact on the TMI-1 Boral test coupon surveillance program in that the existing TMI-1 program continues as planned, with removal of test coupons for examination by the measuring laboratory continuing as per the surveillance program. An Exelon evaluation of the Seabrook operating experience determined that Exelon fleet and industry Boral surveillance programs will continue to provide data that can be interpreted by company and support organizations to determine if further action is required.

Blisters are characterized by a local area where the Boral aluminum cladding separates from the aluminum and boron carbide core and the clad is plastically deformed outward away from the core. Water intrusion into the aluminum and boron carbide core of the Boral material may

occur through small voids present in the core due to the manufacturing process, and can react with the aluminum powder to form aluminum oxide and hydrogen. The appearance of blisters suggests their mechanism of formation is related to a local pressure buildup in the core causing clad/core delamination and subsequent local plastic deformation of the aluminum cladding. Neutron attenuation tests have confirmed that blisters have not altered the neutron absorption properties of the Boral material. However, blister formation has the potential to displace water from the flux trap region of the TMI-1 Region 1 fuel racks, and blister formation occurring in the TMI-1 Region 2 fuel racks has the potential to deform the sheathing material which may cause a reduction of clearance in the fuel storage cell.

In the TMI-1 Region 1 fuel storage racks, water in the flux trap region between the fuel rack storage cells thermalizes neutrons, enhancing the neutron absorber effect. In the event that a blister does not fill with water (whose intrusion into the Boral core resulted in the hydrogen generation that formed the blister), blister formation in the Boral absorber panels in the Region 1 fuel racks can displace water in the flux trap region, and a localized increase in reactivity (at the blister location) could result.

In the TMI-1 Region 2 fuel storage racks, Boral blister formation sufficient to deform the stainless steel sheathing material could cause a reduction of clearance in the affected storage location. Should blisters occur in more than one Boral panel adjacent to a single cell, and at a coincident axial elevation, the condition could become acute enough to make fuel assembly insertion or removal in that cell difficult. The TMI-1 Region 2 fuel storage rack design, however, reduces this potential due to use of a sheathing material thickness greater than the typical sheathing thickness (and, for example, greater than the sheathing thickness in the TMI-1 Region 1 storage racks, which due to the storage rack design are not subject to cell clearance reduction due to sheathing deformation). Since resistance to sheathing displacement is increased, a subsequent decrease of clearance in the cell is less likely than in a storage rack design that uses thinner sheathing material.

These effects are not safety concerns at TMI-1 since continuation of the TMI-1 Boral test coupon surveillance program through the period of extended operation, as well as monitoring and evaluation of Exelon fleet and industry operational and testing experience, will allow the onset of any degradation in the Boral material to be detected early so that appropriate mitigation measures may be applied.

9. Bulging deformation of storage rack cells that had been observed in some early unvented rack designs was due to swelling of the unvented Boral storage pockets when hydrogen gas was generated during development of the protective oxide film on the aluminum surface of the Boral material when first immersed in the pool water. Subsequent rack designs, including TMI-1's storage racks, are of the vented design where any hydrogen that may be generated during the passivation process is permitted to escape the rack cell's Boral panel storage pocket.

Swelling was observed in early foreign applications of Boral in storage racks manufactured in the 1980s. The cause of swelling in these early panels was corrected in later production by instituting appropriate controls on the boron carbide chemical composition. The Holtec-procured Boral panels utilized in TMI-1's storage racks were manufactured under quality assurance/quality control programs that conform to the requirements of 10 CFR 50 Appendix B. These Boral panels have performed well in the industry in part as a result of the development of

a Holtec procurement specification for Boral, which imposed stricter controls on the manufacturing process and amounts of key materials.

Generalized corrosion and localized pitting corrosion of the aluminum cladding material of the Boral panels can occur in the spent fuel pool environment. However, in the boric acid solution typical of TMI-1 and other PWR spent fuel pools, generalized corrosion does not occur. The EPRI *Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage, 2006 Edition*, has reported that localized pitting has been observed in test specimens. Causes were determined to be the presence of corrosion occurring along the boundaries of long thin grains along the edge of the Boral material caused by the rolling processing, impurities in the aluminum powder and boron carbide used to manufacture the core matrix, and incomplete cleaning of metallurgical oils used in the rolling process. These corrosion degradations have not resulted in any decrease in Boron-10 areal density, and consequently have not diminished the Boral material's effectiveness in neutron absorption.

These effects are not safety concerns at TMI-1 since continuation of the TMI-1 Boral test coupon surveillance program through the period of extended operation, as well as monitoring and evaluation of Exelon fleet and industry operational and testing experience, will allow the onset of any degradation in the Boral material to be detected early so that appropriate mitigation measures may be applied.

10. The Water Chemistry program manages loss of material due to general corrosion of the aluminum cladding of the Boral material by controlling and monitoring the spent fuel pool water chemistry. The boric acid solution concentration in the spent fuel pool water inventory is maintained at a goal level to assure that loss of material due to general corrosion of the aluminum cladding of the Boral material is adequately managed. The spent fuel pool water inventory is sampled and analyzed for Boron on a frequency of at least once per seven days. The goal concentration for Boron in the spent fuel pool water inventory is greater than or equal to 2500 ppm, and less than 5000 ppm. If the Boron concentration is found to be less than the minimum goal value, plant Operations, and Chemistry Supervision are to be immediately notified, with actions initiated to return the parameter to the specified range. Per the EPRI *Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage, 2006 Edition*, in a 2500 ppm boric aid solution, generalized corrosion of aluminum does not occur.

In addition to Boron, the spent fuel pool water inventory is sampled and analyzed for parameters including pH, Chloride, Fluoride, Sulfate, Silica, Aluminum, Calcium, Magnesium, and others. More details on the Water Chemistry program, B.2.1.2, are available in the TMI-1 LRA in Appendix B.

The following addition is made to the Appendix A, A.5 License Renewal Commitment List:

No.	Program or Topic	Commitment	UFSAR Supplement Location (LRA Appendix A)	Enhancement or Implementation Schedule	Source
43.	***Boral Test Coupon Surveillance***	***Boral test coupon surveillance will continue through the period of extended operation.***	***N/A***	***Ongoing***	***Response to RAI 3.3.2.2.6-1***

Enclosure B
SUMMARY OF REGULATORY COMMITMENTS

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	PROGRAMMATIC (Yes/No)
RAI#: 3.3.2.2.6-1 ***Boral test coupon surveillance will continue through the period of extended operation.***	***Prior to the period of extended operation***	No	Yes