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

10 CFR 50.4

SUSQUEHANNA STEAM ELECTRIC STATION
RESPONSE TO GENERIC LETTER 2016 -01
REQUEST FOR SUPPLEMENTAL INFORMATION
PLA-7704

Docket No. 50-387
50-388

References:

1. *NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," April 7, 2016.*
2. *SSES Letter (PLA-7518), "Susquehanna Steam Electric Station Response to Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools,"" dated October 31, 2016 (ADAMs Accession No. ML16305A323).*
3. *Letter from D. A. Broaddus, NRC, to Multiple Stations, "Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"- Request for Supplemental Information (CAC Nos. MF9406, MF9407, MF9408, MF9412, MF9413, MF9418, MF9419, MF9421, MF9422, and MF9451; EPID L-2016-LRC-0001), dated December 18, 2017 (ADAMs Accession No. ML17304B153).*

On April 7, 2016, the NRC issued Generic Letter (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" (Reference 1) to all power reactor licensees except those that have permanently ceased operation with all power reactor fuel removed from on-site spent fuel pool storage. Susquehanna Steam Electric Station (SSES) provided a response to this GL for both Unit 1 and 2 under PLA-7518 (Reference 2).

In December 2017, the NRC requested supplemental information from multiple stations, including SSES relative to GL 2016-01 in order to complete the review (Reference 3). The purpose of this letter is to provide the SSES response to the NRC request for supplemental information. The response to the RAI identified for SSES (RAI-2) in reference 3 is provided in the attachment to this letter.

This letter contains no new regulatory commitments. Should you have any questions regarding this submittal, please contact Mr. Jason Jennings, Manager- Nuclear Regulatory Affairs at (570) 542-3155.

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

Executed on: May 24, 2018

B. Berryman

Attachment:

1) SSES Response to NRC Request for Supplemental Information- Generic Boral Question 2

Copy: NRC Region I
Ms. T. E. Hood, NRC Project Manager
Ms. L. H. Micewski, NRC Sr. Resident Inspector
Mr. M. Shields, PA DEP/BRP

PLA-7704 Attachment 1:

SSES Response to NRC Request for Supplemental Information- Generic Boral Question 2

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Generic Boral –RAI-2:

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.68, "Criticality accident requirements," and 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 62, "Prevention of criticality in fuel storage and handling," provide the requirements for licensees with regards to maintaining subcriticality in the spent fuel pool (SFP).

For licensees that utilize neutron absorbing materials (NAM) in the SFP, the properties of the NAM must be known so that the assumptions in the SFP nuclear criticality safety (NCS) analysis of record (AOR) are supported. In order to verify whether or not the requirements of 10 CFR 50.68 and GDC 62 will be met, the staff needs to verify that the potential reactivity changes due to degradation or physical changes to the NAM are accounted for in the SFP NCS AOR. This includes any changes that would affect the neutron spectrum for the SFP in addition to any loss of neutron attenuation capability.

Industry operating experience, as described in Information Notice 2009-26, "Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool," dated October 28, 2009 (ADAMS Accession No. ML092440545), has demonstrated that certain manufacturing processes and plant conditions (dose, chemistry, length of time installed, and installation configuration) have resulted in material deformation as a result of blisters associated with Boral.

SSES has indicated that similar operating experience was identified as a result of its site-specific monitoring program. Please discuss the criticality impact due to the material deformation identified at SSES, and whether it can be accommodated by the NCS AOR at SSES without exceeding NRC subcriticality requirements.

SSES Response to Generic Boral-RAI-2:

The Susquehanna Steam Electric Station (SSES) response to Generic Letter (GL) 16-01 (Reference 1) summarizes the plant specific Boral coupon monitoring program, monitoring results, condition of the spent fuel pool Boral neutron absorber material (including observed degradation and deformations), and how the criticality analysis of record (AOR) models the neutron absorber material. Detailed information can be found under the response to item 1e of Reference 1. A summary of the Susquehanna coupon monitoring program status and up-to-date operating experience since submittal of Reference 1 is provided below.

SSES completed the latest Spent Fuel Pool (SFP) coupon analysis in September 2015 from the Unit 1 Spent Fuel Pool. The results of this analysis showed the lowest B-10 areal density was 0.0257 gm/cm^2. The average areal density was 0.0267 gm/cm^2 for all the coupons tested. Results of coupon testing of the neutron absorber have provided no indication of loss of neutron absorbing material. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP (i.e., 0.0233 gm/cm^2). This value (0.0233 gm/cm^2) is credited in the SSES SFP Nuclear Critically Safety Analysis of Record (NCS AOR).

The neutron absorber material (Boral) is sealed within two concentric square aluminum tubes referred to as poison cans. The neutron absorbing material is not exposed to the Spent Fuel Pool environment. Sample coupons are either vented or non-vented. The non-vented coupons simulate the expected condition of the racks since the Boral neutron-absorber is not in contact with demineralized water. The non-vented coupons have not shown any blistering, pitting, corrosion, or loss of neutron-absorbing capability. The vented coupons simulate a failed poison can weld or other deformation, allowing demineralized water into the area with the Boral plates. The vented samples have shown blistering near the edges of the plate due to the porous nature of the cut edge of the plate (where water interacts with the Boral matrix and generates gasses which can produce blisters on the plate). Neutron attenuation testing (as described above for the September 2015 analysis) has shown that these vented plates still retain the required design properties for neutron attenuation, with no adverse trend.

Susquehanna has internal operating experience with isolated events involving confirmed and potential poison can deformation. This operating experience was described in response to an NRC Request for Additional Information (RAI) for the SSES License Renewal Amendment request in 2009 (Reference 2) and re-stated in the SSES GL 2016-01 response in 2016 (Reference 1). The License Renewal RAI response (Reference 2) describes an incident in March 2006 in which a blade guide could not be inserted into Unit 1 Spent Fuel Pool cell C-13. A subsequent visual (camera) inspection identified bulging (toward the interior of cell C-13) of one of the four poison can interior walls. Inspection of empty adjacent cells did not show any deformation to the outer poison can walls. Cell C-13 is empty and administratively controlled to prevent placement of fuel. Further, Cell C-13 is in an area of the fuel pool reserved for storage of control blade guides. The cause of the cell deformation has been determined to be either hydrogen gas generation from moisture contained in the Boral at time of manufacture or a leaking seal weld in the poison can allowing contact of the Boral plate with demineralized water resulting in swelling from gases generated from the interaction.

Reference 2 also reports that in September 2008, an attempt to remove an irradiated fuel assembly from Unit 1 Spent Fuel Pool cell PP-2 was unsuccessful. Visual (camera) inspections of cell PP-2 and the surrounding four (empty) face adjacent cells did not identify any poison can deformation or the presence of foreign material causing interference with the fuel assembly. The fuel assembly remains in cell PP-2 with the surrounding face adjacent cells defueled and administratively controlled to prevent placement of fuel.

In September 2017, an attempt to remove an irradiated fuel assembly from U1 Spent Fuel Pool cell EE-3 was unsuccessful. Visual (camera) inspections of cell EE-3 and the surrounding four (empty) face adjacent cells identified bulging on one of the four poison can outer walls (toward empty cell DD-3). The fuel assembly remains in cell EE-3 with the surrounding face adjacent cells defueled and administratively controlled to prevent placement of fuel.

Susquehanna considers the condition of U1 SFP cells C-13, PP-2, and EE-3 to be isolated incidents which are not indicative of a widespread condition. This conclusion is drawn from the volume of fuel and blade guide moves conducted annually for refueling, dry fuel storage, and spent fuel pool configuration management. The Susquehanna Spent Fuel Pools contain over 5000 locations where spent fuel assemblies are typically stored. During fuel handling activities over the past five years (January 2013- January 2018), approximately 56% of fuel storage locations have been exercised with fuel insert and/or withdrawal. Additional storage locations are exercised by inserting/withdrawing double or single control blade guides. In 2017, a single fuel storage location, EE-3, was identified to contain a stuck fuel assembly. Cells PP-2 and C-13 were identified in 2008 and 2006, respectively.

The time between events demonstrates a low frequency of occurrence. The continued volume of annual blade guide and fuel moves in the spent fuel pool (which are necessary to support routine operations) serves to identify future interference events. Future events will be entered into the Susquehanna Corrective Action Program.

The Susquehanna nuclear criticality safety (NCS) analysis of record (AOR) credits the minimum certified areal density (0.0233 gm/cm^2) with no consideration of deformation of the Boral neutron absorbing material (i.e. blisters, pits, or bulging). The AOR is supported by coupon monitoring program results (i.e., no loss of areal density or attenuation for either vented or non-vented coupons) and the isolated nature of Susquehanna operating experience with observed cell deformation (C-13, EE-3) or potential cell deformation (PP-2).

Studies have been performed by SSES's fuel vendor, using the NCS AOR model, for ATRIUM-10 fuel, to assess potential reactivity changes, including impacts on the neutron spectrum for the SFP. The studies were performed for two conservative scenarios based on Susquehanna's operating experience.

- Scenario 1: Criticality studies were performed to determine the reactivity impact of blisters on the Boral plates. For this scenario, blisters 0.125 inches in height and 1.25 inches in diameter are assumed to be uniformly distributed (edge-to-edge) on one side of a Boral plate (blisters are assumed to have a spherical shape). A representation of this assumption is then applied to the model by conserving volume, resulting in an equivalent uniform region of hydrogen gas at the surface of the Boral plate. This representation is conservatively applied to every Boral plate in the modeled rack geometry. Based on this scenario, blister formation was found to have an insignificant effect on the k-effective of the Susquehanna Spent Fuel Pool.

- Scenario 2: Studies were performed to determine the impact of storage cell poison can deformation. The storage cell deformation studies model the effect of the poison can wall expanding toward the fuel channel and displacing water in the poison can/fuel channel gap. For these studies, the fuel channel/poison can gap was modeled with varying concentrations of hydrogen gas, ranging from zero to a concentration representative of liquid water at room temperature. This approach was conservatively applied to all cells in the modeled storage array. The bounding condition was found to be when all moderator was removed from the poison can/fuel channel gap (i.e. zero hydrogen concentration). The study demonstrated a maximum k-effective (with a 95/95 confidence level) of 0.928, thus maintaining the requirement that k-effective remain < 0.95.

Therefore, based on the studies performed with the SSES NCS AOR, the neutron absorber material deformation identified at SSES can be accommodated by the NCS AOR without exceeding NRC subcriticality requirements.

References

1. PLA-7518, "Susquehanna Steam Electric Station Response to Generic Letter 2016-01, Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," October 31, 2016

(ADAMS Accession No. ML16305A323).

2. PLA-6504, "Susquehanna Steam Electric Station Request for Additional Information for the Review of the Susquehanna Steam Electric Station Units 1 and 2, License Renewal Application (LRA) Section 3.3.2.2.6," May 13, 2009 (ADAMS Accession No. ML091520031).