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Mandy Halter
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CNRO-2018-00001

February 8, 2018

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

Subject: Response to Request for Supplemental Information Regarding Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools" for Grand Gulf Nuclear Station Unit 1 and Pilgrim Nuclear Power Station

Grand Gulf Nuclear Station, Unit 1	Pilgrim Nuclear Power Station
Docket No. 50-416	Docket No. 50-293
License No. NPF-29	License No. DPR-35

References:
1) NRC Generic Letter 2016-01 dated April 7, 2016, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools" (ML16097A169)
2) Licensee letter dated November 1, 2016, "Response to Generic Letter 2016-01, Grand Gulf Nuclear Station (ML16306A433)
3) Licensee letter dated November 3, 2016, "Response to Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools," Pilgrim Nuclear Power Station (ML16319A131)
4) NRC letter dated November 13, 2017, "Grand Gulf Nuclear Station, Unit 1; Indian Point Nuclear Generating Unit No. 3, Pilgrim Nuclear Power Station; and Waterford Steam Electric Station, Unit 3 – Request for Supplemental Information Regarding Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools" (ML 17304A980)

Dear Sir or Madam:

Following receipt of Generic Letter 2016-01 (Reference 1), Entergy Operations, Inc. and Entergy Nuclear Operations, Inc. (the licensees) provided responses for Grand Gulf Nuclear Station (Reference 2) and Pilgrim Nuclear Power Station (Reference 3), respectively. Following receipt of the Request for Supplemental Information (Reference 4), the licensees are submitting the response to Enclosures 3 and 5. The response to Enclosures 4 and 6 will be submitted by May 31, 2018. Attachment 1 contains the response to Enclosure 3. Attachment 2 contains the response to Enclosure 5.

Should you have any questions or require additional information, please contact John Giddens, Senior Manager, Fleet Regulatory Assurance, at (601) 368-5756.

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

Executed on the 8th day of February, 2018.

Respectfully,

Mandy K Halter

Mandy Halter
Director, Nuclear Licensing

MKH/jjn/gpn

Attachments:

1) Grand Gulf Nuclear Station Response to Request for Supplemental Information Regarding Generic Letter 2016-01, “Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”

2) Pilgrim Nuclear Power Station Response to Request for Supplemental Information Regarding Generic Letter 2016-01, “Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”

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ATTACHMENT 1 TO CNRO-2018-00001

Grand Gulf Nuclear Station Response to

Request for Supplemental Information Regarding Generic Letter 2016-01,

“Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”

REQUEST FOR SUPPLEMENTAL INFORMATION
ENTERGY OPERATIONS. INC.
GRAND GULF NUCLEAR STATION, UNIT 1
DOCKET NO. 50-416

In a letter dated November 1, 2016 (Agencywide Documents Access and Management System Accession No. ML 16306A433), Entergy Operations, Inc. (the licensee) provided information in response to Generic Letter (GL) 2016-01 for Grand Gulf Nuclear Station, Unit 1 (GGNS). The U.S. Nuclear Regulatory Commission (NRC) staff requests supplemental information to complete its review.

Plant-Specific Monitoring Information

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 Criteria for Nuclear Power Plants," 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 boron-10 (^{10}B) areal density (AD) of the NAM must be verified so that the assumption for the 108 minimum AD in the SFP criticality analysis is supported. In order for the NRC staff to verify the requirements of 10 CFR 50.68 and GDC 62 are met, the staff needs to ensure the programs in place to monitor the condition of the NAM in the SFP are appropriate for their intended purpose. In addition, the condition of the NAM must be considered in the SFP nuclear criticality safety (NCS) analysis of record (AOR). In order to verify whether or not the requirements of 10 CFR 50.68 and GDC 62 will be met, the NRC 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.

GGNS-1. In the Updated Final Safety Analysis Report (UFSAR), the licensee states that spent fuel racks are installed in the upper containment pool. The NRC staff believes that the upper containment pool racks are covered by the scope of GL 2016-01. Please provide the appropriate information requested by GL 2016-01 for the upper containment pool racks described in the UFSAR. (See GGNS Response A which starts on the following page.) In addition, if these racks are removable, describe any potential impacts from wetting/drying the NAM, any surveillance measures in place to detect these impacts, and any corrective actions to mitigate these impacts. (See GGNS Response B on page 8.)

GGNS Response A:

The information requested by GL 2016-01 for the upper containment pool racks is addressed in the GL-2016-01 Areas of Requested Information (ARI), Appendix A format that follows.

ARI 1

1) *Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:*

a) manufacturers, dates of manufacture, and dates of material installation in the SFP

b) neutron-absorbing material specifications:

i. materials of construction, including the certified content of the neutron absorbing component expressed as weight percent

ii. minimum certified, minimum as-built, maximum as-built and nominal as-built areal density of the neutron-absorbing component

iii. material characteristics, including porosity, density and dimensions

c) qualification testing approach for compatibility with the SFP environment and results from the testing

d) configuration in the SFP

i. method of integrating neutron-absorbing material into racks (e.g., inserts, welded in place, spot welded in place, rodlets)

ii. *sheathing and degree of physical exposure of neutron absorbing materials to the spent fuel pool environment*

Response

The Spent Fuel Storage Racks in the Upper Containment Pool (UCP) are made of the same material and design, and were installed at the same timeframe, as the racks in the Spent Fuel Pool (SFP). Therefore, the responses to all items listed above are the same as those for the SFP racks, sent in Reference 2 on November 1, 2016.

e) current condition of the credited neutron-absorbing material in the SFP

i. estimated current minimum areal density

Response

The most recent RACKLIFE calculation for the UCP shows the peak panel at a 9.44% B_4C loss on October 7, 2015, which corresponds to an areal density of 0.0185 g/cm^2. There are no Region II panels in the UCP.

ii. *current credited areal density of the neutron-absorbing material in the NCS AOR*

Response

The current credited areal density in the NCS AOR is the same as that for the SFP racks, sent in Reference 2 on November 1, 2016.

iii. *recorded degradation and deformations of the neutron-absorbing material in the SFP (e.g., blisters, swelling, gaps, cracks, loss of material, loss of neutron-attenuation capability)*

Response

See the response to ARI 2 for explanation on how the degradation of the SFP racks bound that of the UCP racks. It is expected that any degradation found in the SFP would also be found in the UCP, but to a lesser extent. See Reference 2 sent to the NRC on November 1, 2016 for a detailed description of the recorded degradation in the SFP racks.

ARI 2

2) *Describe the surveillance or monitoring program used to confirm that the credited neutron-absorbing material is performing its safety function, including the frequency, limitations, and accuracy of the methodologies used.*

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

i. approach used to determine frequency, calculations and sample size

ii. parameters to be inspected and data collected

iii. acceptance criteria of the program and how they ensure that the material's structure and safety function are maintained within the assumptions of the NCS AOR

iv. monitoring and trending of the surveillance or monitoring program data

v. industry standards used

b) *For the following monitoring methods, include these additional discussion items:*

   i. *If there is visual inspection of in-service material:*

      1. *Describe the visual inspection performed on each sample.*

      2. *Describe the scope of the inspection (i.e., number of panels or inspection points per inspection period).*

   ii. *If there is a coupon monitoring program:*

      1. *Provide a description and technical basis for how the coupons are representative of the material in the racks. Include in the discussion, the material radiation exposure levels, SFP environment conditions, exposure to the SFP water, location of the coupons, configuration of the coupons (e.g., jacketing or sheathing, venting bolted on, glued on, or free in the jacket, water flow past the material, bends, shapes, galvanic considerations, and stress-relaxation considerations), and dimensions of the coupons.*

      2. *Provide the dates of coupon installation for each set of coupons.*

      3. *If the coupons are returned to the SFP for further evaluation, provide the technical justification of why the reinserted coupons would remain representative of the materials in the rack.*

      4. *Provide the number of coupons remaining to be tested and whether there are enough coupons for testing for the life of the SFP. Also provide the schedule for coupon removal and testing.*

   iii. *If RACKLIFE is used:*

      1. *Note the version of RACKLIFE being used (e.g., 1.10, 2.1).*

      2. *Note the frequency at which the RACKLIFE code is run.*

      3. *Describe the confirmatory testing (e.g., in-situ testing) being performed and how the results confirm that RACKLIFE is conservative or representative with respect to neutron attenuation.*

      4. *Provide the current minimum RACKLIFE predicted areal density of the neutron-absorbing material in the SFP. Discuss how this areal density is calculated in RACKLIFE. Include in the discussion whether the areal densities calculated in RACKLIFE are based on the actual as-manufactured areal density of each panel, the nominal areal density of all of the panels, the minimum certified areal density, the minimum as-manufactured areal density, or the areal density credited by the NCS AOR. Also discuss the use of the escape coefficient and the total silica rate of Boraflex degradation in the SFP*

iv. *If in-situ testing with a neutron source and detector is used (e.g., BADGER testing, blackness testing):*

1. *Describe the method and criteria for choosing panels to be tested and include whether the most susceptible panels are chosen to be tested. Provide the statistical sampling plan that accounts for both sampling and measurement error and consideration of potential correlation in sample results. State whether it is statistically significant enough that the result can be extrapolated to the state of the entire pool.*

2. *State if the results of the in-situ testing are trended and whether there is repeat panel testing from campaign to campaign.*

3. *Describe the sources of uncertainties when using the in-situ testing device and how they are incorporated in the testing results. Include the uncertainties outlined in the technical letter report titled "Initial Assessment of Uncertainties Associated with BADGER Methodology," September 30, 2012 (Agency wide Access and Management Systems Accession No. ML12254A064). Discuss the effect of rack cell deformation and detector or head misalignment, such as tilt, twist, offset, or other misalignments of the heads and how they are managed and accounted for in the analysis.*

4. *Describe the calibration of the in-situ testing device, including the following:*

   a. *Describe how the materials used in the calibration standard compare to the SFP rack materials and how any differences are accounted for in the calibration and results.*

   b. *Describe how potential material changes in the SFP rack materials caused by degradation or aging are accounted for in the calibration and results.*

   c. *If the calibration includes the in-situ measurement of an SFP rack "reference panel", explain the following:*

      i. *the methodology for selecting the reference panel(s) and how the reference panels are verified to meet the requirements,*

      ii. *whether all surveillance campaigns use the same reference panel(s)*

      iii. *If the same reference panels are not used for each measurement surveillance, describe how the use of different reference panels affects the ability to make comparisons from one campaign to the next.*

Response

The UCP racks are only allowed to have irradiated fuel in them when the reactor is shutdown. Since fuel assemblies are not stored in the UCP racks during plant operation, their use is limited to short durations during refueling outages for the temporary storage of fuel assemblies. Thus, their accumulated doses and boron losses are well bounded by the racks in the SFP, as shown by the RACKLIFE models for each set of racks. For this reason, neutron attenuation testing is only conducted in the SFP racks. Please see Reference 2 sent to the NRC on November 1, 2016 for the detailed description of the Boraflex monitoring program at GGNS.

The Boraflex monitoring program at GGNS includes the UCP racks. A separate RACKLIFE model is maintained for the UCP racks that utilizes the same RACKLIFE version as the SFP. The same escape coefficients as the SFP are used, which ensures the RACKLIFE model is conservative with respect to the actual condition of the UCP rack panels. This model is updated as needed and is projected forward using very conservative parameters (bundle power and time in rack). The last update was performed in November 2015, which projected Boraflex parameters out to February 2022. This update shows the peak panel at a 9.44% B_4C loss on October 7, 2015, which corresponds to an areal density of 0.0185 g/cm^2. The dose and B_4C loss conservatively projected at February 2022 were below the dose and areal density limits, so the UCP RACKLIFE model will be revisited prior to February 2022, unless changes noted in the condition of the SFP racks provide a reason to revisit the UCP model.

ARI 3

3) *For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.*

Response

The multicycle interval of RACKLIFE calculations is allowed due the low amount of dose accumulation and boron loss, limited storage time of assemblies in the UCP racks, and the conservativeness of the projections utilized. The parameters used in the projection are confirmed to continue to be bounding after each refueling outage. As stated before, the SFP racks are bounding with respect to the UCP racks. If anything unexpected is found there, then the UCP analysis would be revisited prior to the designated interval to address the unexpected finding.

ARI 4

4) *For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR, and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR:*

a) Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.

b) *Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.*

c) *Describe how the bias and uncertainty of the monitoring or surveillance program are used in the SFP NCS AOR.*

d) *Describe how the degradation in adjacent panels is correlated and accounted for in the NCS AOR.*

Response

The UCP racks use the same AOR as the SFP racks and the Boraflex monitoring program includes the UCP racks. As discussed in the response to ARI 2 above, this monitoring program includes a RACKLIFE model for the UCP. Thus, the answers to this ARI are the same as those found in Reference 2 sent to the NRC on November 1, 2016.

ARI 5

5) *For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).*

a) *For each design-basis event that would have an effect on the neutron-absorbing material, describe the technical basis for determining the effects of the design-basis event on the material condition of the neutron-absorbing material during the design-basis event, including:*

i. *shifting or settling relative to the active fuel*

ii. *increased dissolution or corrosion*

iii. *changes of state or loss of material properties that hinder the neutron-absorbing material's ability to perform its safety function*

b) *Describe how the monitoring program ensures that the current material condition of the neutron-absorbing material will accommodate the stressors during a design-basis event and remain within the assumptions of the NCS AOR, including:*

i. *monitoring methodology*

ii. parameters monitored

iii. acceptance criteria

iv. intervals of monitoring

Response

The UCP degradation is bounded by the SFP and the Boraflex monitoring program includes the UCP racks, so these answers are the same as those found in Reference 2 sent to the NRC on November 1, 2016.

GGNS Response B

The UCP racks are not removable unless being replaced via maintenance or design change. Inventory is maintained over top of active reactor fuel during normal operations and during an inadvertent dump of the upper pool makeup volume to the suppression pool. Therefore, no surveillance measures are needed to detect the impacts of wetting and drying on the NAM.

ATTACHMENT 2 TO CNRO-2018-00001

Pilgrim Nuclear Power Station Response to

Request for Supplemental Information Regarding Generic Letter 2016-01,

“Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”

REQUEST FOR SUPPLEMENTAL INFORMATION
ENTERGY NUCLEAR OPERATIONS, INC.
PILGRIM NUCLEAR POWER STATION
DOCKET NO. 50-293

In a letter dated November 3, 2016 (Agencywide Documents Access and Management System Accession No. ML 16319A131), Entergy Nuclear Operations, Inc. (the licensee) provided information in response to the Generic Letter 2016-01 for Pilgrim Nuclear Power Station (PNPS). The U.S. Nuclear Regulatory Commission (NRC) staff requests supplemental information to complete its review.

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 Criteria for Nuclear Power Plants," General Design Criteria (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 (SPF). For licensees that utilize neutron absorbing materials (NAM) in the SFP, the boron-10 (^{10}B) areal density (AD) of the NAM must be verified so that the assumption for the ^{10}B minimum AD in the SFP criticality analysis is supported. In order for the NRC staff to verify the requirements of 10 CFR 50.68 and GDC 62 are met, the staff needs to ensure the programs in place to monitor the condition of the NAM in the SFP are appropriate for their intended purpose. In addition, the condition of the NAM must be considered in the SFP nuclear criticality safety (NCS) analysis of record (AOR). In order to verify whether or not the requirements of 10 CFR 50.68 and GDC 62 will be met, the NRC 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.

PNPS-1 In the response to Question 1(a), the licensee states that the N1 and N2 SFP racks were installed in January of 1995. However, in the response to Question 2(b)ii.2., it states that the Boral coupons were placed in the SFP in November of 1999. Please describe how the Boral coupons are representative of the inservice material given the nearly 5-year difference in time that the material has been exposed to the SFP conditions.

PNPS Response

Based on the historical records, January 1995, is the correct date for installation of the N1 and N2 racks in the PNPS SFP.

Based on the retrieval of additional historical records, the November 1999 date given for the installation of the Boral coupons was an incorrect date. PNPS records show that the coupon tree was verified to be in a Boral rack cell on November 12, 1996. These records also show that irradiated fuel assemblies were first loaded into the Boral racks in February 1997. Therefore, the coupon tree was installed prior to the loading of irradiated fuel assemblies into the Boral racks. The coupons were placed in leading locations with respect to parameters affecting degradation. Thus, the Boral coupons are considered to be representative of the in-service material of the Boral racks.