



Entergy Operations, Inc.
Entergy Nuclear Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213

Mandy Halter
Director, Nuclear Licensing

CNRO-2018-00021

May 30, 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 Indian Point Energy Center, Unit 3 and Waterford 3 Steam Electric Station

Indian Point Energy Center, Unit 3
Docket No. 50-286
License No. DPR-64

Waterford 3 Steam Electric Station
Docket No. 50-382
License No. NPF-38

- References:
- 1) Entergy 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)
 - 2) Entergy Letter dated November 3, 2016, "Response to Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools", Response to NRC Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f)", (ML16314E266)
 - 3) Entergy Letter dated November 2, 2016, "Waterford 3 Response to Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools", (ML16307A275)
 - 4) NRC Generic Letter 2016-01 dated April 7, 2016, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools", (ML16097A169)
 - 5) EPRI Evaluation of Impact of Blisters and Pits in Neutron Absorber Panels on Spent Fuel Pool Reactivity. EPRI, 3002013119

Dear Sir or Madam:

Entergy Operations, Inc. and Entergy Nuclear Operations, Inc. (the licensees) submitted letters dated November 3, 2016, (Reference 2) and November 2, 2016 (Reference 3) providing information in response to the GL 2016-01 (Reference 4).

To complete its review, the Nuclear Regulatory Commission (NRC) staff requested the licensees to provide the supplemental information requested in Enclosures 3-6 of NRC letter dated November 13, 2017 (Reference 1). During a discussion between NRC and Entergy staff on October 23, 2017, it was agreed that Entergy would provide response for:

- Enclosures 3 and 5 within 90 days from the date of the letter; and
- Enclosures 4 and 6 by May 31, 2018.

This letter responds to Enclosures 4 and 6 as requested.

- Attachment 1 contains the response to Enclosure 4 for Indian Point Energy Center Unit 3.
- Attachment 2 contains the response to Enclosure 6 for Waterford 3 Steam Electric Station.

This letter contains no new regulatory commitments.

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

I declare under penalty of perjury, the foregoing is true and correct. Executed on 30th day of May 2018

Respectfully,



Mandy Halter
Director, Nuclear Licensing

MKH/jjn/gpn

- Attachments:
1. Indian Point Energy Center Unit 3, Response to Request for Supplemental Information Regarding Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools", Enclosure 4
 2. Waterford 3 Steam Electric Station, Response to Request for Supplemental Information Regarding Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools", Enclosure 6

cc: NRC Region I Administrator
NRC Project Manager (IPEC)
NRC Senior Resident Inspector (IPEC)

NRC Region IV Administrator
NRC Project Manager (WF3)
NRC Senior Resident Inspector (WF3)

Project Manager, NRC/NRR/DORL

ATTACHMENT 1

CNRO-2018-00021

**Indian Point Energy Center Unit 3, Response to
Request for Supplemental Information Regarding Generic Letter 2016-01,
“Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”,
Enclosure 4**

NRC Request Indian Point Energy Center, Unit 3

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 Indian Point Energy Center, Unit 3 (IP3). The U.S. Nuclear Regulatory Commission (NRC) staff requests supplemental information to complete its review.

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 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 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 (as opposed to the neutron spectrum used for attenuation testing purposes) 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.

IP3 has indicated that similar operating experience was identified as a result of their site-specific monitoring program. Please discuss the criticality impact due to the material deformation identified at IP3, and how it can be accommodated by the NCS AOR at IP3 without exceeding NRC subcriticality requirements.

IP3 Response to Generic Boral-RAI-2

To date, the industry operating experience (OE) has revealed no instances of an impact on SFP criticality due to observed Boral deformation (e.g. blistering) or degradation (e.g. pitting). The Neutron Absorber User Group (NAUG), through the Electric Power Research Institute (EPRI), has recently completed a study (Reference A1-1) which analyzes the criticality impact of blisters and pits on Boral. Simulations were performed for varying enrichment, burnup, and areal density values, at unborated conditions (0 ppm), which is conservative for PWRs such as Indian Point 3. The study results demonstrate that pitting and blistering on a scale much larger than any that has been observed in the industry OE, or in Indian Point 3 site-specific monitoring results, has an insignificant impact on SFP criticality. Therefore, the IP3 SFP nuclear criticality safety analysis of record remains applicable.

Reference

- A1-1. Evaluation of Impact of Blisters and Pits in Neutron Absorber Panels on Spent Fuel Pool Reactivity. EPRI, 3002013119.

ATTACHMENT 2

CNRO-2018-00021

**Waterford 3 Steam Electric Station, Response to
Request for Supplemental Information Regarding Generic Letter 2016-01,
“Monitoring of Neutron Absorbing Materials in the Spent Fuel Pools”,
Enclosure 6**

NRC Request Waterford Steam Electric Station, Unit 3

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 Waterford 3 Steam Electric Station (WF3). The U.S. Nuclear Regulatory Commission (NRC) staff requests supplemental information to complete its review.

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 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 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 (as opposed to the neutron spectrum used for attenuation testing purposes) 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.

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

Waterford 3 Response to Generic Boral-RAI-2

To date, the industry operating experience (OE) has revealed no instances of an impact on SFP criticality due to observed Boral deformation (e.g. blistering) or degradation (e.g. pitting). The Neutron Absorber User Group (NAUG), through the Electric Power Research Institute (EPRI), has recently completed a study (Reference A2-3) which analyzes the criticality impact of blisters and pits on Boral. Simulations were performed for varying enrichment, burnup, and areal density values, at unborated conditions (0 ppm), which is conservative for PWRs such as Waterford 3. The study results demonstrate that pitting and blistering on a scale much larger than any that has been observed in the industry OE, or in Waterford 3 site-specific monitoring results, has an insignificant impact on SFP criticality. Therefore, the Waterford 3 SFP nuclear criticality safety analysis of record remains applicable.

Plant-Specific Monitoring Information

The regulations in 10 CFR 50.68 and GDC 62 provide the requirements for licensees with Enclosure 6 regards to maintaining subcriticality in the SFP. For licensees that utilize 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 NCS AOR. 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.

Waterford-1

During the review of the response to GL 2016-01, the NRC staff compared the information provided to the information in the Waterford License Renewal Application (LRA) to ensure consistency. The NRC staff noted that the LRA contained additional operating experience that was not included in the response to GL 2016-01. Specifically, the operating experience that showed in 2001 black deposits were found on both sides of a coupon. The licensee stated that it "...appeared to be boron carbide that had broken through the aluminum skin of Boral..."

- a. Was this coupon subject to further testing to determine the composition of the black deposits?*
- b. If so, were the black deposits in fact boron carbide that had broken through the aluminum skin of the Boral?*
- c. If the black deposits were boron carbide, please describe how this potential degradation mechanism was treated in the site monitoring program (i.e. any corrective actions taken).*

Waterford 3 Response to Plant-Specific Monitoring Information Waterford-1

- a. The Boral coupon discussed in the Waterford 3 License Renewal Application, serial number R2-1 LW 720822-1-4, was not subject to further tests to determine the composition of the dark deposits. As stated in the coupon testing report from 2001 (Reference A2-1), the dark deposits "appeared to be pieces of boron carbide which had broken through the aluminum skin of the Boral. This likely occurred when BORAL is hot rolled to its final plate configuration." Results of the testing detailed in the report indicated that the Boral coupon had no loss of B-10 areal density when compared to the initially measured values of the coupon before being exposed to the spent fuel pool environment. Measurements of the dimensions of the Boral coupon were within 2% of the initially measured dimensions before installation in the spent fuel pool. The report stated that the Boral coupon was in "good condition" but did not include any qualitative discussion of the dark deposits on the Boral coupon in the conclusion. Per the site procedure (Reference A2-2), the results of the report satisfied the acceptance criteria for

the Boral coupons of no decrease by more than 5% in B-10 content or increase in thickness by more than 10%.

- b. See the response to a. above.
- c. See the response to a. above

Reference

- A2-1. NET-191-01 Inspection and testing of Boraflex and BORAL Surveillance Coupons from Arkansas Nuclear One, Grand Gulf and Waterford Stations.
- A2-2. NE-001-106, "SFSR Boral Surveillance Program".
- A2-3. Evaluation of Impact of Blisters and Pits in Neutron Absorber Panels on Spent Fuel Pool Reactivity. EPRI, 3002013119.