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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR NUCLEAR ENERGY INSTITUTE DOCUMENT,

NEI 16-03, REVISION 1, "GUIDANCE FOR MONITORING OF

FIXED NEUTRON ABSORBERS IN SPENT FUEL POOLS"

PROJECT NO. 689; DOCKET NO. 99902028; EPID L-2022-NTR-0002

Table of Contents

1.0 INTRODUCTION

By letter dated August 19, 2022 (Ref. 1), as supplemented by letters (Ref. 4) dated October 12, 2022, December 15, 2022, May 23, 2023, and August 24, 2023, the Nuclear Energy Institute (NEI) submitted proposed methodology document NEI 16-03, Revision (Rev.) 1, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools" (Ref. 2), on behalf of its members for U.S. Nuclear Regulatory Commission (NRC) review and endorsement. NEI 16-03, Rev. 1 includes Electric Power Research Institute's (EPRI's) Technical Report 3002018497, "Industrywide Learning Aging Management Program (i-LAMP): Global Neutron Absorber Material Monitoring Program for Spent Fuel Pools" (Ref. 3) dated August 2022, as an alternative monitoring approach.

The purpose of NEI's document is to provide guidance for licensees to develop an acceptable fixed neutron absorber monitoring program in spent fuel pools (SFPs) as a means to demonstrate compliance with applicable regulations in Section 50.68 of Title 10 of the *Code of Federal Regulations* (10 CFR), "Criticality Accident Requirements," Appendix A to 10 CFR Part 50, General Design Criterion (GDC) 61, "Fuel Storage and Handling and Radioactivity Control," and Appendix A to 10 CFR Part 50, GDC 62,"Prevention of Criticality in Fuel Storage and Handling," with respect to neutron absorbing materials (NAMs). Although NEI requested the NRC staff to endorse NEI 16-03, Rev. 1, the NRC staff is not proposing to issue a regulatory guide to endorse NEI 16-03. Instead, as stated in this Safety Evaluation (SE), the NRC staff is treating NEI 16-03, Rev. 1, as a topical report, and as described below, the NRC staff has determined that NEI 16-03, Rev. 1 is acceptable, with the limitation described below, for referencing in a license amendment request (LAR) that includes the information described below in Section 4.0 of this SE.

2.0 REGULATORY EVALUTION

The effectiveness of the NAM installed in SFP storage racks ensures that the effective neutron multiplication factor (k_{eff}) does not exceed the maximum value derived from the criticality analysis of record (AOR) and other licensing basis documents. The AOR is the basis, in part, for demonstrating compliance with plant technical specifications and with applicable NRC regulations. Degradation or deformation of the credited NAM may reduce safety margin and potentially challenge the subcriticality requirement. NAMs utilized in SFP racks exposed to treated water or treated borated water may be susceptible to reduction of neutron absorbing capacity, changes in dimension, and/or loss of material that increases k_{eff}. A licensee implements a monitoring program to ensure that degradation of the NAM used in SFPs, which could compromise the ability of the NAM to perform its safety function as presumed in the AOR, will be detected.

2.1 Applicability of NRC Regulatory Requirements and Guidance

NRC's regulatory requirements and the corresponding staff review criteria and guidance for NAM monitoring programs are identified in the following subsections.

2.1.1 NRC Regulations

The regulations in 10 CFR 50.68(b)(4), "Criticality accident requirements," indicates that if the licensee does not credit soluble boron in the SFP criticality AOR, the k_{eff} of the SFP storage racks must not exceed 0.95 at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If the licensee does take credit for soluble boron, the k_{eff} of the SFP storage racks must not exceed 0.95 at a 95 percent probability, 95 percent confidence level, if flooded with borated water; and if flooded with unborated water, the k_{eff} must remain below 1.0 at a 95 percent probability, 95 percent confidence level.

2.1.2 General Design Criteria

- GDC 61, "Fuel storage and handling and radioactivity control," states, in part, that "The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety[.]"

- GDC 62, "Prevention of Criticality in Fuel Storage and Handling," states that "Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations."

2.1.3 NRC Guidance Documents

- NUREG-0800, "Standard Review Plan [(SRP)]," Section 9.1.1, Rev. 3, "Criticality Safety of Fresh and Spent Fuel Storage and Handling" (Ref. 7) provides guidance regarding the acceptance criteria and review procedures to ensure that the proposed changes satisfy the requirements in 10 CFR 50.68.

- NUREG-0800, "Standard Review Plan," Section 9.1.2, Rev. 4, "New and Spent Fuel Storage" (Ref. 8) provides guidance regarding the acceptance criteria and review procedures to ensure that the proposed changes satisfy the requirements in 10 CFR 50.68.

- NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," Rev. 2 (Ref. 9) provides guidance on what constitutes an acceptable monitoring program for NAMs providing criticality control in the SFP.

3.0 TECHNICAL EVALUATION

This technical evaluation section documents the NRC staff's evaluation of the NEI 16-03, Rev. 1 against the relevant criteria identified in Section 2.0 of this SE.

3.1 Guidance for Developing a Neutron Absorbing Monitoring Program

NEI 16-03, Rev. 1 provides guidance for developing a NAM monitoring program for NAM in the SFP. The purpose of a NAM monitoring program is to verify that the NAM installed in SFPs continues to provide the criticality control relied upon in the AOR and help to maintain the subcriticality margin in accordance with 10 CFR 50.68 requirements. NEI 16-03, Rev. 1 provides an approach for developing a NAM monitoring program that relies on periodic inspection, testing, monitoring, and analysis of the NAM. To accomplish this purpose, the NEI 16-03, Rev. 1 states that a monitoring program must be capable of identifying unanticipated changes in the absorber material and determining whether anticipated changes can be verified. NEI 16-03, Rev. 1 describes a method that uses coupon testing, in-situ measurement, and/or an i-LAMP as a means to monitor potential changes in characteristics of the NAM.

The NRC staff reviewed NEI 16-03, Rev. 1 to determine whether the approach it describes will result in an acceptable monitoring program, i.e., one that has the ability to ensure that potential degradation of SFP NAM will be detected, monitored, and mitigated. As set forth below, the NRC staff determined that an appropriate combination of the three methods listed above (coupon testing, in-situ measurement, and/or i-LAMP) can comprise an effective NAM monitoring program. During the course of NRC staff's review, several topics were identified that warranted clarification. The NRC staff issued a request for additional information (Ref. 10) and NEI provided clarifying responses and modified NEI 16-03, Rev. 1 as appropriate.

3.2 Coupon Testing Program

3.2.1 Overview of NEI 16-03, Revision 1

NEI 16-03, Rev. 1 describes the use of a coupon testing program as the preferred method for a NAM monitoring program. This method employs small sections (coupons) of the same NAM installed in the SFP, which are attached to a structure (coupon tree) in the SFP. The coupon tree is placed near freshly discharged fuel assemblies in an attempt to accelerate potential degradation mechanisms.

NEI 16-03, Rev. 1 provides the following criteria for an acceptable coupon program:

- The number of coupons needs to be adequate to allow for sampling at intervals for the intended life of the absorbers.
- The sampling intervals are based on the expected rate of material change.
- Performance of coupon testing includes:

  - Basic testing defined as visual observations, dimensional measurements, and weight analysis, and

  - Full testing defined as density measurements, Boron-10 (^{10}B) areal density (AD) measurements, microscopic analysis, and characterization of changes, in addition to the basic testing parameters.

NEI 16-03, Rev. 1 states that the coupons will be located in the SFP "such that their exposure to parameters controlling change mechanisms is conservative or similar to the in-service neutron absorbers." For neutron attenuation testing, NEI 16-03, Rev. 1 provides acceptance criteria for the NAM depending on if there is, or is not, an anticipated loss of ^{10}B AD. The acceptable result for NAMs with expected ^{10}B AD loss is the ^{10}B AD of the test coupon is greater than the ^{10}B AD assumed in the licensee's SFP criticality AOR. For NAM without an expected loss of ^{10}B AD, the acceptable result is the ^{10}B AD of the test coupon is equal to the original ^{10}B AD of the coupon (within measurement uncertainty).

In regard to sampling frequency, NEI 16-03, Rev. 1 states that the acceptable initial sampling interval for testing of new material (i.e., with a limited, or no, operating history) is up to 5 years, with subsequent intervals up to 10 years. For those materials that have well-documented operating experience, they do not have a history of degradation or degradation mechanisms, and information on stability of the material condition is well developed. NEI 16-03, Rev. 1 states that initial and subsequent test intervals up to 10 years are acceptable. NEI 16-03, Rev. 1 states that for materials with known degradation mechanisms, or a history of known degradation (e.g., Boraflex, Carborundum, Tetrabor, etc.), the acceptable interval for neutron attenuation testing is at least once every five years. In addition, NEI 16-03, Rev. 1 includes neutron attenuation testing in the full testing approach for any NAMs used, as a component of a satisfactory NAM monitoring program.

3.2.2 <u>NRC Staff's Evaluation of the Coupon Testing Program</u>

The NRC staff has evaluated NEI 16-03, Rev. 1 for the basic and full portions of a coupon testing program. The basic portion of the testing includes methods to monitor the physical condition of the NAM so that signs of potential degradation may be observed. The full portion of the testing includes neutron attenuation testing for all NAMs that are credited in the SFP criticality analysis, which will allow the licensee to detect a potential loss in ^{10}B AD. The staff finds the coupon testing program to be acceptable because it includes measurements of ^{10}B AD and of dimensional changes in the material that can impact the ability of the NAM to perform its function as assumed in the licensee's SFP criticality AOR.

The NRC staff also determined the acceptance criteria for the coupon testing program provided in NEI 16-03, Rev.1 is acceptable, as follows. The acceptance criteria are adequate to establish that the presumptions regarding the AD of the NAM in the licensee's SFP criticality AOR will be maintained, because the acceptance criteria show that the material is either not losing ^{10}B AD (for materials not expected to lose ^{10}B AD), or the ^{10}B AD is still above the ^{10}B AD presumed in the licensee's SFP criticality AOR (for NAM anticipated to lose ^{10}B AD). In addition, the NRC staff recognizes that if a coupon being tested approaches the ^{10}B AD value used in the licensee's SFP criticality AOR, the licensee would likely need to perform further evaluations and/or take additional corrective actions to conclude that the in-service NAM will not degrade below the ^{10}B AD presumed in the licensee's SFP criticality AOR. Provisions for additional corrective actions that may be necessary are discussed in Section 2.4, "Evaluating Neutron Absorber Test Results," of NEI 16-03, Rev. 1, and NRC staff's evaluation is discussed in Section 3.5 of this SE.

NEI 16-03, Rev. 1 also states that coupons may be re-inserted into the SFP after non-destructive examination and analysis as long as the coupons are not subjected to heat drying which may cause mechanical damage. The NRC staff understands that the re-installation of coupons may be valuable for licensees that have a limited number of coupons remaining. As stated previously, coupon testing is the preferred method for NAM monitoring and efforts to maintain the coupon inventory are acceptable if the reinserted coupons will continue to yield valid data.

3.3 <u>Industrywide Learning Aging Management Program</u>

3.3.1 <u>Overview of NEI 16-03, Revision 1</u>

The primary difference between NEI 16-03, Rev. 0 and NEI 16-03 Rev. 1 is the addition of i-LAMP as an alternative monitoring option for BORAL plants that do not have surveillance coupons in their SFP. The objective of i-LAMP is to provide access to surrogate or "sibling" pool data for plants that do not have a coupon monitoring program. The i-LAMP approach is not intended to serve as a replacement for a coupon monitoring program for SFPs with coupons.

The core of i-LAMP is an SFP coupon database. EPRI compiled data from existing coupon test reports and continues to add data as new test results become available.

NEI 16-03, Rev. 1 states that the following data is being collected from plants with BORAL coupon monitoring programs:

- Pool name
- Rack installation year
- Rack type (egg crate versus flux trap)
- Stainless steel encapsulation or not
- Coupon unique identification (ID) number
- Coupon analysis year(s), if the same coupon is analyzed multiple times
- Dimension data (pre-characterization and post-irradiation)

  - Height, width, thickness
  - Weight
  - Areal density values (pre-characterization and post-irradiation)
  - Pit and blister data

To participate in i-LAMP and leverage surrogate test results for an SFP, a facility that does not have a BORAL coupon monitoring program identifies a sibling plant or plants in the existing database.

The essential parameters needed to identify an appropriate sibling plant is listed below:

- Similarity of BORAL characteristics

  - Areal density values
  - Manufacturing and installation years
  - Thickness

- Similarity of water chemistry data between SFPs

  - Boron levels
  - Chlorine, Fluorine, Sulfate levels
  - Other chemistry parameters

NEI 16-03 Rev. 1 calls for licensees to review i-LAMP data at least every 5 years to confirm the continued acceptable performance of sibling pool BORAL.

Acceptance Criteria are described as follows:

- The sibling pool BORAL material is represented in the i-LAMP database. Representation is determined using the parameters described above including material age, areal density, and SFP water chemistry.
- Applicable surrogate data has been updated with new operating experience within the last 10 years, unless older data remains bounding for the sibling pool.
- Applicable surrogate data does not indicate unanticipated changes are occurring.
- Applicable surrogate data confirms that there is no loss of ^{10}B within the measurement uncertainty.

NEI 16-03 Rev. 1 states that based on major research projects conducted by EPRI and data collected from the industry, there are no known degradation mechanisms that have resulted in loss of ^{10}B in BORAL. Because of this, NEI 16-03, Rev. 1 proposes a “2 bin” approach which separates plants into those with coupons and those without coupons. NEI 16-03, Rev. 1 proposes that plants without coupons are bounded by the collective database of plants with coupons and therefore do not need to perform a detailed analysis to confirm that they are bounded by a sibling plant or plants. The NRC staff’s evaluation of this concept is provided below.

3.3.2. NRC Staff’s Evaluation of the Industrywide Learning Aging Management Program

The NRC staff has evaluated the proposal in NEI 16-03, Rev. 1, for the implementation of i-LAMP surrogate test data for BORAL plants without a coupon monitoring program. The staff finds that the guidance provides adequate detail with respect to the essential parameters needed to identify a sibling plant. Specifically, the manufacture date, areal density, service life, physical thickness of the BORAL, and its SFP environment including chemistry should be consistent with or bounded by the characteristics of the BORAL and the service environment in a sibling plant in the existing database.

In addition, the staff finds that the acceptance criteria and surveillance intervals described in NEI 16-03 Rev. 1 conform to the NRC guidance in the GALL Report, Rev. 2. The acceptance criteria provide reasonable assurance that the assumptions regarding the AD of the NAM in the licensee’s SFP criticality AOR will be maintained, because the acceptance criteria show that the material not losing ^{10}B AD and is still above the ^{10}B AD assumed in the licensee’s SFP criticality AOR.

With respect to the concept of a “2 bin” approach, the staff finds that NEI 16-03 Rev. 1 represents an overly simplistic approach. While it may be true that the data collected in i- LAMP to date anecdotally bounds all operating SFPs in the United States, the NRC staff is approving use of the i-LAMP approach only for a SFP for which the i-LAMP data bounds the physical characteristics of the BORAL and environmental conditions in the specific SFP. A licensee seeking to reference NEI 16-03, Rev. 1 in an application will need to verify in its application that such is the case. Any licensee that intends to employ i-LAMP as an alternative monitoring strategy should perform a detailed analysis of their SFP and BORAL material considering the parameters described in NEI 16-03 Rev 1. Failure to perform plant-specific analysis to verify that parameters are consistent with a sibling SFP, or bounded by an older SFP’s BORAL, constitutes inappropriate application of i-LAMP as an alternative monitoring strategy. This will be addressed in Section 4.0, “Limitations and Conditions” of this safety evaluation.

Should a new or different degradation mechanism that causes a loss of ^{10}B in BORAL be discovered, NEI 16-03, Rev. 1, calls for that information to be entered into each affected site’s corrective action program. This may include development a coupon monitoring program, or use of in-situ monitoring. If the sibling plant data shows a loss of ^{10}B, then the licensee needs to assume that its plant is also losing ^{10}B and develop another means to monitor its NAM.

3.4. In-Situ Measurement Program

3.4.1. Overview of NEI 16-03, Revision 1

NEI 16-03, Rev. 1 states that in-situ measurement is another method that can be used to confirm ^{10}B AD of NAM. It further states that this method can be used to supplement coupon monitoring to extend the coupon testing interval, permit greater reliance on basic testing, or in lieu of coupon testing for plants that may no longer have coupons in the SFP. It also states that in-situ measurement can be used if surrogate data in i-LAMP may not be bounding of a plant's SFP and NAM parameters.

The NEI 16-03, Rev. 1 states that all in-situ measurement campaigns are to be performed at an acceptable interval and on an adequate number of panels. NEI 16-03, Rev. 1 gives two options for determining what constitutes an adequate number of panels. The first option uses the methodology of NUREG-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology" (Ref. 10), to measure a minimum of 59 panels to provide 95/95 confidence limits. The second option selects the panels with the greatest exposure (top 5%) to parameters that influence degradation (e.g., neutron fluence, temperature, time). The number of panels selected from those with the greatest exposure for testing will be no less than one percent of the total panels in the SFP, although more panels can be tested from other areas of the SFP to gain a more representative sampling. NEI 16-03, Rev. 1 also states sources of uncertainty in the in-situ measurement will be identified and quantified.

The sampling interval will be based upon the NAM credited in the SFP. New materials with minimal operating experience will have an initial test interval that does not exceed 5 years, with subsequent intervals up to 10 years (with appropriate operating experience). For materials with known histories of degradation and known degradation mechanisms, test intervals do not exceed 5 years. For other materials that do not have known histories of degradation or known degradation mechanisms test intervals will not exceed 10 years. NEI 16-03, Rev. 1 also states that if used in conjunction with a coupon monitoring program, the in-situ sampling interval can be longer.

NEI 16-03, Rev. 1 also provides acceptance criteria for in-situ measurements. It states that for NAMs that do not have potential degradation mechanisms for loss of ^{10}B AD, results of the in-situ measurements are acceptable if the nominal measured ^{10}B AD is greater than or equal to the value assumed in the licensee's criticality AOR (within measurement uncertainties). For materials that have potential degradation mechanisms that result in loss of ^{10}B AD, results are considered acceptable if the nominal measured ^{10}B AD minus measurement uncertainty is greater than the ^{10}B AD used in the licensee's criticality AOR.

3.4.2. NRC Staff's Evaluation of In-Situ Measurement Program

The NRC staff has reviewed the NEI 16-03, Rev. 1 method for performing in-situ measurement testing and finds it to be acceptable, because it allows for detection of degradation mechanisms, potential loss of neutron absorption capacity (e.g., loss of ^{10}B), and ensures the NAM will continue to provide the criticality control relied upon in the AOR. The NRC staff reviewed the methodology recommended for determining the number of panels that may be selected for in-situ inspection and finds it to be acceptable because it is based in part on guidance provided in NUREG-6698, or on selecting panels that have experienced the greatest exposure to the SFP environment. The NRC staff also finds that depending on the population of NAM panels in the SFP, a licensee may need to measure more than the minimum of 59 panels to produce 95/95 confidence limits. The method used for selecting the panels for in-situ testing will be used to obtain data that is bounding or representative of the entire NAM in the SFP.

In addition, the NRC staff has determined that the proposed testing intervals (intervals not to exceed 10 years for materials with no known history of degradation/degradation mechanisms, and 5 years for materials with a known history of degradation/degradation mechanisms or for new materials (i.e., no operating history)) are acceptable and consistent with NRC guidance in the GALL Report, Rev. 2. Regardless of how the licensee uses the in-situ monitoring program (e.g., in conjunction with coupons, without a coupon program, or other reasons as described in NEI 16-03, Rev. 1), NEI 16-03, Rev. 1 is acceptable only if neutron attenuation is performed on the intervals as described in the in-situ methodology. The statement in NEI 16-03, Rev. 1 that the in-situ sampling interval can be longer if used in conjunction with a coupon program does not obviate the need to perform neutron attenuation testing on intervals not to exceed 5 or 10 years (depending on the NAM used and associated operating experience).

In addition, sources of uncertainty can greatly impact results and confidence in the data collected, especially as it relates to the subcriticality margin. Accordingly, the NRC staff finds the program to be acceptable if it includes provisions to identify and evaluate sources of uncertainty in order to assess the reliability of the instruments and methodology used to the collect the data.

3.5. Evaluating Neutron Absorber Test Results

3.5.1. Overview of NEI 16-03, Revision 1

NEI 16-03, Rev. 1 states that the test results from neutron absorber monitoring may fall within the following categories:

1) Confirmation that no material changes are occurring,

2) Confirmation that anticipated changes are occurring, and/or

3) Identification that unanticipated changes are occurring.

Furthermore, NEI 16-03, Rev. 1 states that the testing results, and/or surrogate i-LAMP data, will be compared to the AOR input (i.e., ^{10}B AD assumed in criticality AOR). If there are no material changes, or if anticipated changes are occurring, then the proposed program indicates that the licensee can conclude that the material continues to be adequately represented in the AOR.

NEI 16-03, Rev. 1 also describes the additional actions that may be necessary when unanticipated changes in the NAM are identified. It states that there are certain technical evaluations that may be necessary in addition to any required regulatory or licensing processes. The technical evaluations include one to determine if an unanticipated change in NAM may result in a loss of ^{10}B AD. Any potential impacts of a loss of ^{10}B AD on the SFP criticality AOR will be evaluated and addressed through licensee processes. In addition, the results of monitoring and testing are to be evaluated and trended, regardless of potential impact on the SFP criticality AOR. If an unanticipated change does not appear to result in the loss of ^{10}B AD, the change will still be evaluated for impacts on the SFP criticality AOR. The effects on the SFP criticality AOR due to a potential dimensional change of the NAM, or other material in the SFP, are evaluated and addressed in accordance with licensee processes.

3.5.2. <u>NRC Staff's Evaluation of Neutron Absorber Test Results</u>

The NRC staff has reviewed the actions described in NEI 16-03 Rev. 1 for when potential degradation is detected in the neutron absorbing material as potential degradation of the NAM may impact ^{10}B AD presumptions in the SFP criticality AOR. The NRC staff finds the actions described in the NEI's document acceptable because they will be able to identify anticipated, and unanticipated changes to provide information that will allow a licensee to determine whether the neutron absorbing material is performing its safety function as credited in the AOR.

The NRC staff has also determined that it is necessary to evaluate and trend the results of ^{10}B AD measurements from neutron attenuation testing in the NAM as described in NEI 16-03, Rev.1. The NRC staff finds the methods to trend data acceptable because they will provide information regarding the potential degradation mechanism(s) and rate for the NAM in the SFP. This information will also help the licensee determine whether the ^{10}B AD of the NAM will not decrease below the value assumed in the SFP criticality AOR between the specified test intervals for neutron attenuation testing. In addition, these data can identify previously un-evaluated degradation mechanisms that may have an impact on the SFP criticality AOR.

The actions described above ensure, in part, that the ability of the NAM to provide the criticality control relied upon in the AOR, is maintained.

3.6. <u>NRC Technical Evaluation Conclusion</u>

As summarized below, the NRC staff has determined that the NAM monitoring program described in NEI 16-03, Rev. 1 is acceptable because it includes neutron attenuation testing at acceptable intervals or relies on testing from a surrogate i-LAMP plant that is acceptable if the surrogate plant SFP and NAM conditions and parameters bound those of the licensee's plant. More specifically, the NRC staff finds the interval for inspection and testing acceptable because the frequency is determined to be based on the neutron absorbing material credited and the operational history of that material. Further, depending on the material used, the interval for neutron attenuation testing will not exceed 5 years (for materials with a history of known degradation or a known degradation mechanism, and new materials), or 10 years (for other materials that do not have a history of degradation, or a known degradation mechanism). Such testing intervals are adequate to detect degradation of NAM before such degradation has the potential to affect criticality safety. Periodic neutron attenuation testing, and the intervals described in NEI 16-03 are consistent with NRC guidance (i.e., the GALL Report, Rev. 2). Licensees will likely need to request site-specific NRC review and approval to extend the interval of any neutron attenuation testing past the approved intervals, as described in NEI 16-03, Rev. 1.

In addition, the NRC staff finds the proposed program acceptable insofar as it calls for the inclusion of the measurement uncertainty in a determination whether the ^{10}B AD value derived from the program is lower than the presumed value in the SFP criticality AOR. If a given test result shows a ^{10}B AD value lower than the value presumed in the SFP criticality AOR, the program provides for the appropriate corrective actions in accordance with licensee programs and processes.

Based on the foregoing, the NRC staff has determined that NEI 16-03, Rev.1 is acceptable for referencing in a LAR requesting approval of a NAM monitoring program.

4.0 CONDITIONS, LIMITATIONS, AND/OR ACTION ITEMS

"Limitations and Conditions" are additional restrictions imposed by the NRC staff to further define the scope of applicability of NEI 16-03 Rev. 1 and identify any additional actions that will need to be addressed to support NRC staff's review of a request associated with this NEI's document.

4.1. Limitations and Conditions

Based on the staff review of NEI 16-03, Rev. 1, described above, the NRC staff has identified the following limitation on the use of the methodology shown below:

The NRC staff approves the NEI 16-03, Rev. 1, methodology for employing i-LAMP as an alternative monitoring strategy *only if* the i-LAMP program provides for the licensee to perform a detailed analysis of its SFP and BORAL material considering the parameters described in NEI 16-03 Rev 1. The i-LAMP alternative strategy is unacceptable unless a plant-specific analysis verifies that SFP conditions and BORAL parameters are consistent with those of a sibling SFP or are bounded by those of an older SFP's BORAL. This limitation is imposed to address the discussion in NEI 16-03 Rev.1 of a "2-bin" system in which plants without coupons are assumed to be bounded by those with coupons.

5.0 CONCLUSIONS

The NRC staff has reviewed NEI 16-03, Rev.1 and the proposed methods for developing a NAM monitoring program. For the reasons discussed in this SE, the staff has determined that a NAM monitoring program implementing the NEI 16-03, Rev. 1 program will be able to detect degradation of neutron absorbing material and provides assurance that the ability of the NAM to provide the criticality control relied upon in the AOR is maintained.

The NRC staff finds that the requirements of 10 CFR 50.68(b)(4), GDC 61, and GDC 62, as well as the guidance provided in SRP 9.1.1, SRP 9.1.2, and the GALL, Rev. 2, would be satisfied with respect to NAMs and the NAM monitoring program if referenced in an LAR requesting use of the program, and, for an application requesting use of i-LAMP as an alternative, that meets the limitation stated in this SE. Accordingly, the NRC staff has concluded that NEI 16-03, Rev. 1 is acceptable for referencing in an application requesting approval of a NAM monitoring program.

Each licensee adopting NEI 16-03, Rev. 1 will need to implement it in accordance with its plant-specific processes and licensing basis. This will involve review under the plant commitment control process and 10 CFR 50.59. Either of these processes could result in the need for a plant-specific license amendment request. Each licensee will need to make its own evaluation in this regard under its site-specific change control program.

6.0 REFERENCES

1. Letter from R. McCullum (NEI) to J. Donoghue (NRC), Transmittal of Guidance Document NEI 16-03, Revision 1, "Request for Review and Endorsement of NEI 16-03, *Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools*, Revision 1 dated August 2022," August 19, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22231B042).

2. Nuclear Energy Institute Guidance Document NEI 16-03, Revision 1, "Request for Review and Endorsement of NEI 16-03, *Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools*," August 2022 (ADAMS Accession No. ML22231B043 (Non-Proprietary).

3. Electric Power Research Institute (EPRI) Technical Report 3002018497, “Industrywide Learning Aging Management Program” (i-LAMP): Global Neutron Absorber Material Monitoring Program for Spent Fuel Pools,” August 2022 (ADAMS Accession No. ML22231B044 (Non-Proprietary).

4. Letters from R. McCullum (NEI) to J. Donoghue (NRC), "Supplement to NEI’s Request for Review and Endorsement of NEI 16-03, “Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools,” Revision 1, dated August 19, 2022", October 12, 2023, (ADAMS Accession No. ML22298A281), and “Response to NRC Request for Supplemental Information Supporting the Acceptance review of NEI 16-03, Rev. 1, *Guidance for*

Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," December 15, 2022 (ADAMS Accession Nos. ML22349A656), and "Response to NRC Request for Additional Information Supporting the Review of NEI 16-03, Rev. 1, *Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools*," May 23, 2023 (ADAMS Accession Nos. ML23143A306), and Letter from B. Montgomery (NEI) to NRC, "NRC Review of NEI 16-03, Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools" August 24, 2023 (ADAMS Accession No. ML23236A503).

5. Nuclear Energy Institute 16-03, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," Revision 0-A, May 2017 (ADAMS Accession Nos. ML17263A133 and ML16354A486 (FSE)).

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