U.S. NUCLEAR REGULATORY COMMISSION

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FRESH AND SPENT FUEL POOL CRITICALITY ANALYSES

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes an approach that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to demonstrate that NRC regulatory requirements are met for subcriticality of fuel assemblies stored in fresh fuel vaults and spent fuel pools at light-water reactor (LWR) power plants. It endorses, with clarifications and exceptions, the Nuclear Energy Institute (NEI) guidance document NEI 12-16, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants," Revision 4, (Ref. 1).

Applicability

This RG applies to licensees and applicants subject to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," (Ref. 2), or 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," (Ref. 3). With respect to 10 CFR Part 50, this RG applies to holders of and applicants for a construction permit or operating licenses. With respect to 10 CFR Part 52, this RG applies to holders of and applicants for combined licenses, standard design certifications, standard design approvals, and manufacturing licenses.

Applicable Rules and Regulations

- 10 CFR Part 50, "Domestic licensing of production and utilization facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion 62, "Prevention of criticality in fuel storage and handling," (Ref. 4), requires that criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.
    - 10 CFR 50.68, "Criticality accident requirements," contains criticality accident requirements for a construction permit or operating license for nuclear power reactors issued under 10 CFR Part 50 or a combined license issued for a nuclear power reactor under 10 CFR Part 52. Specifically, this RG provides guidance for licenses or applicants to comply with the criticality safety requirements of 10 CFR 50.68(b).

- 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," governs the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power facilities.

    - 10 CFR 52.79(a)(43) requires that applications for a combined license must include sufficient information to demonstrate compliance with the requirements of 10 CFR 50.68.

    - 10 CFR 52.47(a)(17) requires that applicants for a standard design certification comply with the requirements for criticality accidents in 50.68(b)(2)-(b)(4).

    - 10 CFR 52.137(a)(17) requires that applicants for a standard design approval comply with the requirements for criticality accidents in 50.68(b)(2)-(b)(4).

    - 10 CFR 52.157(a)(8) requires that applicants for a manufacturing license comply with the requirements for criticality accidents in 50.68(b)(2)-(b)(4).

- 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," (Ref. 5), governs the issuance of licenses to receive, possess, deliver, and transfer special nuclear material.

    - 10 CFR 70.24, "Criticality accident requirements," provides that licensees authorized to possess special nuclear material that exceeds specified amounts, must maintain a monitoring system to detect criticality, maintain emergency response plans should a criticality occur, and to periodically conduct drills to exercise those plans. A common practice was for commercial power reactor licensees to request exemptions to 10 CFR 70.24. Typically, those exemptions were granted if the licensee demonstrated sufficient subcriticality to criteria very similar to those in 10 CFR 50.68(b)(2)-(4). When the NRC issued 10 CFR 50.68 in 1998, licensees had the option to retain their exemption to 10 CFR 70.24. This guidance applies to the applicable portions of those exemptions.

Related Guidance

In addition to the NUREG and NUREG/CR documents listed in NEI 12-16, Revision 4, the following documents may include information that is useful to users of this guidance.

- NUREG-1475, "Applying Statistics," (Ref. 6), provides an overview of different statistical approaches that may be used in demonstrating compliance with the requirement in 10 CFR 50.68(b) for 95-percent probability, 95-percent confidence level, including limitations on their area of applicability.

- NUREG/CR-7108, "An Approach for Validating Actinide and Fission Product Burnup Credit Criticality Safety Analyses—Isotopic Composition Predictions," (Ref. 7), provides guidance on the expected uncertainty associated with actinides and fission products in nuclear criticality safety analyses where the burnup of the spent fuel assemblies is credited.

- NUREG/CR-6683, "A Critical Review of the Practice of Equating the Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analyses for PWR Spent Fuel Pool Storage," (Ref. 8), describes limitations to the use of "fresh fuel equivalencing" methods used by some licensees.

- NUREG/CR-1547, "Criticality Experiments with Subcritical Clusters of 2.35 Wt% and 4.31 Wt% ^{235}U Enriched UO_2 Rods in Water at a Water-to-Fuel Volume Ratio of 1.6," (Ref. 9), provides an additional source of experiments for criticality code validation.

- NUREG/CR-7109, "An Approach for Validating Actinide and Fission Product Burnup Credit Criticality Safety Analyses—Criticality (k_{eff}) Predictions," (Ref. 10), provides additional information relevant to using NUREG/CR-7108.

- NUREG/CR-7194, "Technical Basis for Peak Reactivity Burnup Credit for BWR Spent Nuclear Fuel in Storage and Transportation Systems," (Ref. 11), provides additional information regarding the use of boiling water reactor fuel peak reactivity in criticality analyses.

- RG 1.13, "Spent Fuel Storage Facility Design Basis," (Ref. 12), may be applicable because of its discussion of systems, structures, and components that are relied upon by the nuclear criticality safety analysis.

- Information Notice 1997-77, "Exemptions from the Requirements of Section 70.24 of Title 10 of the Code of Federal Regulations," dated October 10, 1997 (Ref. 13), provides the Commission's position on review of exemptions to 10 CFR 70.24.

- Interim Staff Guidance (ISG) DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," (Ref 14). Issued in 2011, this ISG provided guidance to the NRC staff to support the review of methods for performing criticality analyses submitted for demonstrating compliance with 10 CFR 50.68.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated events, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Parts 50 and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), approval numbers 3150-0011 and 3150-0151. Send comments regarding this information collection to the Information Services Branch (T6-A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the OMB reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011 and 3150-0151), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW Washington, DC 20503; e-mail: oira_submission@omb.eop.gov.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

B. DISCUSSION

Reason for Issuance

This guide describes an acceptable approach for applicants and licensees subject to 10 CFR Parts 50 or 52 to demonstrate that NRC regulatory requirements are met for subcriticality of fuel assemblies stored in fresh fuel vaults and spent fuel pools at LWR power plants. This guidance provides clarity and consistency regarding the necessary scope of efforts for applicants and licensees to demonstrate compliance with the requirements of 10 CFR 50.68(b) for performing criticality analyses of fuel storage at LWR power plants and maintain exemptions to 10 CFR 70.24. Specifically, this RG endorses, with clarifications and exceptions, the NEI guidance document NEI 12-16, Revision 4.

This RG updates and supersedes DSS-ISG-2010-01, which will be withdrawn upon issuance of this RG. Licensees that already use DSS-ISG-2010-01 to demonstrate compliance with NRC requirements may continue using that guidance as long as they do not change their licensing bases relative to that guidance.

Background

Over the years, criticality analyses for LWR power plant spent fuel pool storage racks and fresh fuel vaults have increased in complexity. Various changes have reduced safety margins relative to the regulatory requirements in 10 CFR 50.68(b), such as high-density storage racks, increased enrichment, and degradation of neutron absorber materials. The lack of explicit NRC guidance and the lack of standardization in spent fuel pool storage requirements led to multiple licensing reviews that exceeded normal review time frames. Therefore, the NRC found it necessary to provide guidance to support the review of methods for performing criticality analyses submitted for demonstrating compliance with 10 CFR 50.68(b). These analyses are integral to the technical foundation for the design of nuclear fuel storage structures, systems, and components, and the associated technical specifications in applications (i.e., license amendment requests) submitted to the NRC for review and approval.

In 2011, the NRC issued DSS-ISG-2010-01 to address this need. The intent of DSS-ISG-2010-01 was to clarify ambiguity in existing guidance and to build upon lessons learned based on licensing reviews at the time. While DSS-ISG-2010-01 provided updated guidance to the NRC staff that was responsive to the increased complexity of more recent spent fuel pool license application analyses and operations, it did not consider all aspects of performing criticality analyses of fuel storage at LWR power plants. Therefore, the staff believed that a comprehensive and more specific guidance document for performing criticality analyses of fuel storage at LWR power plants was still necessary.

NEI, in collaboration with the Electric Power Research Institute (EPRI), developed NEI 12-16 to fill this regulatory need. This guidance document represents NEI's effort to outline current practices in nuclear criticality analyses for fuel storage in vaults or pools and to establish a technical basis for certain positions. The most recent version of NEI 12-16, Revision 4, incorporated the final NRC-approved version of the EPRI methodology in Technical Report 3002010613, "Benchmarks for Qualifying Fuel Reactivity Depletion Uncertainty – Revision 1," (Ref. 15). The NRC issued a final safety evaluation for the topical report in a letter dated July 19, 2019 (Ref. 16). On September 26, 2019, NEI submitted NEI 12-16, Revision 4, (Ref. 17), and NEI seeks its endorsement by the NRC through a RG. This RG endorses, with clarifications and exceptions, the guidance described in NEI 12-16, Revision 4, as one acceptable approach to demonstrate compliance with 10 CFR 50.68(b).

Consideration of International Standards

The International Atomic Energy Agency (IAEA) works with member states and other partners to promote the safe, secure, and peaceful use of nuclear technologies. The IAEA develops Safety Standards and Safety Guides for protecting people and the environment from harmful effects of ionizing radiation. This system of safety fundamentals, safety requirements, safety guides, and other relevant reports reflects an international perspective on what constitutes a high level of safety. To inform its development of this RG, the NRC considered IAEA Safety Requirements and Safety Guides[1] pursuant to the Commission's International Policy Statement (Ref. 18) and Management Directive and Handbook 6.6 (Ref. 19). In development of this RG, the NRC considered IAEA Specific Safety Guide (SSG-27), "Criticality Safety in the Handling of Fissile Material," (Ref. 20).

Documents Discussed in Staff Regulatory Guidance

This RG endorses, in part, the use of NEI 12-16, Revision 4, which is a third party guidance document. NEI 12-16 may contain references to other codes, standards or third party guidance documents ("secondary references"). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a RG, then the secondary reference is neither a legally-binding requirement nor a "generic" NRC approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

1 IAEA Safety Requirements and Guides may be found at WWW.IAEA.Org/ or by writing the International Atomic Energy Agency, P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria; telephone (+431) 2600-0; fax (+431) 2600-7; or e-mail Official.Mail@IAEA.Org. It should be noted that some of the international recommendations do not correspond to the requirements specified in the NRC's regulations, and the NRC's requirements take precedence over the international guidance.

C. STAFF REGULATORY GUIDANCE

1. The NRC staff considers the guidance in NEI 12-16, Revision 4, with clarifications and exceptions, acceptable as a means for demonstrating compliance with the requirements in 10 CFR 50.68(b). The NRC staff provides these clarifications and exceptions to certain technical positions and statements in NEI 12-16, Revision 4, as discussed below:

a. Section 1.4 states that the double contingency principle, as applied to criticality accidents, means, in part, that licensees do not need to consider the simultaneous occurrence of two independent and unlikely conditions. The example provided discusses conditions that are controlled through technical specification requirements. A licensee or applicant may consider certain conditions to be unlikely conditions, such as the possibility that a burnable absorber panel may not have been correctly installed. However, if no controls or documents exist to preclude such a condition, then the licensee or applicant should treat it as part of the normal condition.

b. The last paragraph of Section 1.6 discusses the concept of using a "graded" licensing approach to use risk insights, which is consistent with current licensing practices. Licensees or applicants should establish how they will maintain any excess safety margins being used to justify assumptions or simplifications when they update the criticality analyses, using their approved methodology, to accommodate changes in the fuel storage characteristics.

c. Section 2 discusses acceptance criteria for fresh fuel vault storage and states that one of the situations for which an evaluation does not need to be performed in accordance with 10 CFR 50.68(b) is when a licensee has been granted an exemption to 10 CFR 70.24. This only applies if the licensee maintains the conditions upon which the exemption was based. If the conditions deviate from the conditions for which the exemption was justified, then the licensee or applicant may need to justify why the exemption is still valid or perform an evaluation.

d. Section 3.1.3 discusses the treatment of nuclides credited in the depletion and criticality analysis; however, it doesn't provide any guidance on the treatment of lumped fission products which may be used in certain depletion codes. The NRC has previously accepted approaches in which the lumped fission products are included in the depletion calculations but removed from the isotopic compositions before use in the criticality analysis. If licensees or applicants use lumped fission products in their estimation of k_{eff} of the spent fuel pool, then they should justify their treatment of lumped fission products separately from the treatment of individual actinides and fission products.

e. Section 4.2.3 states that the depletion bias and uncertainty described in this section account for all uncertainties associated with depletion. If licensees are following the guidance in Section 4.3.1 about treatment of the depletion parameters, the staff would find this approach acceptable. Licensees or applicants that do not follow the guidance in Section 4.2.3 should justify that they are adequately accounting for the depletion uncertainties.

f. Section 4.3.1 discusses the lattice-specific parameters that should be accounted for when considering which types of lattices to evaluate. Section 4.3.1 should not be considered to provide a complete list of parameters. Each unique axial plane in the bundle designs should be evaluated. For example, some bundle designs may use different fuel rod pitches at different axial planes. Licensees or applicants should justify their selection of lattice parameters for evaluation.

g. Section 5.1.6 discusses a conservative approach to modeling integral burnable absorbers using nominal dimensions combined with a minimum absorber loading. To meet the 95-percent probability, 95-percent confidence requirement of 10 CFR 50.68(b), licensees or applicants should ensure that the minimum absorber loading is based on the lower 95/95 threshold of the manufacturing tolerance range, or the manufacturing tolerances should be evaluated and treated as an uncertainty.

h. Section 5.2.2 states that credit can be taken for radial leakage near the walls of the spent fuel pool for allowing lower burnup fuel requirements on the periphery of the spent fuel pool. Licensees or applicants that adopt this approach should include the spent fuel pool wall in their nuclear criticality safety analyses to account for the weak neutron reflection capability of the concrete wall, unless the distance between fuel and the spent fuel pool wall is sufficiently large to assure that the influence of the wall on criticality is not significant.

i. Section 5.2.2.4 provides recommendations on the treatment of eccentric positioning for fuel assemblies within spent fuel pool cells. These recommendations are acceptable as general guidelines; however, the NRC does not endorse a generic justification for not analyzing specific configuration based on a qualitative assessment of probability. Licensees or applicants should consider any unique aspects of the configuration being analyzed that may lead to a more limiting eccentric positioning.

j. Section 6.3 includes the following statement:

> For pressurized-water reactor (PWR) spent fuel pools that credit soluble boron, the limiting misload will be the accident which requires the highest soluble boron to ensure that the maximum k_{eff} does not exceed 0.95.

The NRC agrees that the limiting abnormal condition will be the one which requires the highest soluble boron to meet regulatory requirements. However, while misloading events are typically the limiting abnormal condition, that is not always the case; therefore, licensees or applicants should consider all credible abnormal and accident conditions.

k. Section 9.4 lists some parameters that may need to be verified as part of post irradiation fuel characterization activities. One of the parameters is "soluble boron (burnup averaged)." The NRC endorses use of cycle burnup averaged soluble boron, consistent with Section 4.2.1, but the NRC does not endorse other interpretations of the phrase "burnup averaged," such as averaging across the whole burnup range for a given fuel assembly.

l. Section A.1 provides recommendations for the validation of computer codes used for nuclear criticality safety analyses, as well as referencing NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," issued January 2001 (Ref. 21), for additional information. An important aspect of validation that is not covered in much detail is the importance of selecting appropriately representative benchmarks and critical experiments, especially when performing trend evaluation. Licensees or applicants may need to consider smaller sets of data to avoid confounding effects that obscure trends or that lead to conclusions based on data that are not highly representative of the spent fuel pool geometry and compositions of interest.

m. Section A.2.2 states that startup critical data from boiling-water reactors (BWRs) can be used to benchmark depletion codes and compute a bias and bias uncertainty. NEI 12-16, Revision 4, does

not provide clear guidance on how to accomplish this assessment, and it is not a commonly accepted practice. Therefore, licensees or applicants that use such an approach would need to provide technical justification to the NRC for review and approval, including why the critical data are applicable to the compositions and to which geometries the benchmarking is intended be applicable.

n. Section A.4 discusses use of a secondary code as an intermediate means to validate the primary code used for the nuclear criticality safety analyses. This is not an approach that the NRC has recently received for review and approval, and there is no justification for this approach in NEI 12-16, Revision 4. Therefore, the NRC does not endorse this approach as a generally acceptable means of validating a code intended specifically for use in the nuclear criticality safety analyses (as opposed to use in the generation of spent fuel isotopic compositions or screening of fuel lattices for evaluation).

o. NEI 12-16, Revision 4, provides many recommendations that are based on analyses performed using typical geometries and compositions associated with spent fuel pools and bundle designs that are currently in widespread use in the United States (e.g., cylindrical uranium dioxide fuel pellets enclosed in zirconium alloy tubes). Novel configurations and concepts, such as accident-tolerant fuel designs, may require justification for continued use of the assumptions. For example, dispositions of specific uncertainties as not significant may no longer be valid, simplifying assumptions may become nonconservative, and additional uncertainties may need to be considered. Licensees or applicants are responsible for justifying use of the guidance in NEI 12-16, Revision 4, in any such applications.

p. NEI 12-16, Revision 4, includes some general conclusions based on sensitivity studies performed to support the guidance. The NRC's endorsement of NEI 12-16, Revision 4, should not be considered a determination that the conclusions are applicable for all licensees or applicants. Licensees or applicants should ensure that a conclusion is applicable to their circumstances before implementing the guidance associated with that conclusion.

q. Appendix B to NEI 12-16, Revision 4, includes an example to supplement the guidance. The NRC's endorsement of NEI 12-16, Revision 4, should not be considered a determination that the example provided in Appendix B is applicable for all licensees or applicants. Licensees or applicants should ensure that the example in Appendix B is applicable to their circumstances before implementing the guidance as described in the example.

D. IMPLEMENTATION

The NRC staff may use this RG as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this RG to support NRC staff actions in a manner that would constitute backfitting, as that term is defined in 10 CFR 50.109, "Backfitting," and as described in NRC Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," (Ref. 22), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval under 10 CFR Part 52. The staff also does not intend to use the guidance to support NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this RG in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

REFERENCES[2]

1. Nuclear Energy Institute, NEI 12-16, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants," Revision 4, Washington, DC (ADAMS Accession No. ML19269E069).

2. *U.S. Code of Federal Regulations* (CFR), "Domestic licensing of production and utilization facilities," Part 50, Chapter 1, Title 10, "Energy."

3. CFR, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52, Chapter 1, Title 10, "Energy."

4. 10 CFR Part 50, "Domestic licensing of production and utilization facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 62, "Prevention of criticality in fuel storage and handling."

5. CFR, "Domestic licensing of special nuclear material," Part 70, Chapter 1, Title 10, "Energy."

6. U.S. Nuclear Regulatory Commission (NRC), NUREG-1475, "Applying Statistics," Revision 1, Washington, DC, March 2011 (ADAMS Accession No. ML11102A076)

7. NRC, NUREG/CR-7108, "An Approach for Validating Actinide and Fission Product Burnup Credit Criticality Safety Analyses—Isotopic Composition Predictions," ORNL/TM-2011/509, Oak Ridge National Laboratory, Washington, DC, April 2012. (ADAMS Accession No. ML12116A124)

8. NRC, NUREG/CR-6683, "A Critical Review of the Practice of Equating the Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analyses for PWR Spent Fuel Pool Storage," ORNL/TM-2000/230, Oak Ridge National Laboratory, Washington, DC, September 2012 (ADAMS Accession No. ML003751298)

9. NRC, NUREG/CR-1547, "Criticality Experiments with Subcritical Clusters of 2.35 Wt% and 4.31 Wt% ^{235}U Enriched UO_2 Rods in Water at a Water-to-Fuel Volume Ratio of 1.6," PNL-3314, Pacific Northwest National Laboratory, Washington, DC, July 1980. (ADAMS Accession No. ML070310488)

10. NRC, NUREG/CR-7109, "An Approach for Validating Actinide and Fission Product Burnup Credit Criticality Safety Analyses—Criticality (keff) Predictions," ORNL/TM-2011/514, Oak Ridge National Laboratory, Washington, DC April 2012 (ADAMS Accession No. ML12116A128)

2 Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. The documents can also be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.

11. NRC, NUREG/CR-7194, "Technical Basis for Peak Reactivity Burnup Credit for BWR Spent Nuclear Fuel in Storage and Transportation Systems," ORNL/TM-2014/240, Oak Ridge National Laboratory, Washington, DC, April 2015 (ADAMS Accession No. ML15097A186

12. NRC, Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis," Washington, DC.

13. NRC, Information Notice 1997-77, "Exemptions from the Requirements of Section 70.24 of Title 10 of the Code of Federal Regulations," Washington, DC, October 10, 1997.

14. NRC, DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," Washington, DC, October 13, 2011 (ADAMS Accession No. ML110620086).

15. Electric Power Research Institute (EPRI) Final Report 3002010613, "Benchmarks for Qualifying Fuel Reactivity Depletion Uncertainty – Revision 1," Palo Alto, California, October, 2017[3] (ADAMS Accession No. ML18088B397).

16. NRC, Letter, "Final Safety Evaluation for the Electric Power Research Institute (EPRI) EPRI Topical Report 3002010613, 'Benchmarks for Qualifying Fuel Reactivity Depletion Undertainty-Revision1,' and Topical Report 3002010614, 'Utilization of the EPRI Depletion Benchmarks for Burnup Credit Validation-Revision 1,'" Washington, DC, September 19, 2019 (ADAMS Accession No. ML19189A112).

17. EPRI, Letter, "Transmittal of EPRI Benchmark Revision 1-A, Utilizations Revision 2-A, and NEI 12-16, Revision 4," Washington, DC, September 26, 2019 (ADAMS Accession No. ML19269E056).

18. NRC, "Nuclear Regulatory Commission International Policy Statement," *Federal Register*, Vol. 79, No. 132, July 10, 2014, pp. 39415-39418.

19. NRC, Management Directive (MD) 6.6, "Regulatory Guides," Washington, DC, May 2, 2016 (ADAMS Accession No. ML18073A170).

20. International Atomic Energy Agency (IAEA) Safety Standards Series No. SSG-27, "Criticality Safety in the Handling of Fissile Material," Vienna, Austria, 2014.[4]

21. NRC, NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," January 2001 (ADAMS Accession No. ML010170125).

22. NRC, MD 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," Washington, DC, September 20, 2019 (ADAMS Accession No. ML18093B087).

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3 Copies of Electric Power Research Institute (EPRI) standards and reports may be purchased from EPRI, 3420 Hillview Ave., Palo Alto, CA 94304; telephone (800) 313-3774; fax (925) 609-1310.

4 Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency, P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria.