

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE 1.227, REVISION 0



Issue Date: June 2019
Technical Lead: Eric Bowman

WIDE-RANGE SPENT FUEL POOL LEVEL INSTRUMENTATION

A. INTRODUCTION

Purpose

This regulatory guide (RG) identifies methods and procedures the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for demonstrating compliance with NRC regulations to provide a reliable means to remotely monitor wide-range spent fuel pool levels to support implementation of event mitigation and recovery actions as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities” (Ref. 1), Section 50.155, “Mitigation of beyond-design-basis events” (10 CFR 50.155).

This RG endorses, with exceptions and clarifications, the methods and procedures promulgated by the Nuclear Energy Institute (NEI) in document NEI 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, ‘To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation’,” Revision 1 (NEI 12-02) dated August 2012 (Ref. 2) as a process the NRC staff considers acceptable for meeting certain regulations in 10 CFR 50.155.

Applicability

This RG applies to applicants and licensees subject to 10 CFR Part 50, and all applicants and licensees for a power reactor combined license under 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 3).

Applicable Regulations

- 10 CFR 50.155(a) makes 10 CFR 50.155(e) applicable to operating power reactor licensees until the NRC has docketed their certifications of permanent cessation of operation and permanent removal of fuel from the reactor vessel.
- 10 CFR 50.155(e) requires each operating power reactor licensee to provide reliable means to remotely monitor wide-range water level for each spent fuel pool at its site until five years have elapsed since all of the fuel within that spent fuel pool (SFP) was last used in a reactor vessel for power generation. 10 CFR 50.155(e) does not apply to General Electric Mark III upper containment pools.

Written suggestions regarding this guide or development of new guides may be submitted through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/reg-guides/contactus.html>.

Electronic copies of this regulatory guide, previous versions of this guide, and other recently issued guides are available through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/>. The regulatory guide is also available through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under ADAMS Accession No. ML19058A013. The regulatory analysis may be found in ADAMS under Accession No. ML19058A009. The associated draft guide DG-1317 may be found in ADAMS under Accession No. ML14245A454, and the staff responses to the public comments on the proposed rule and DG-1317 may be found under ADAMS Accession No. ML19058A007.

Related Guidance

- RG 1.226, “Flexible Mitigation Strategies for Beyond-Design-Basis Events” (Ref. 4). This RG endorses, with exceptions, clarifications, and additions as appropriate, the methodologies described in NEI guidance document NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide” (Ref. 5), as one method of compliance with additional portions of 10 CFR 50.155 that are not addressed in this RG.

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), control 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 request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

Reason for Issuance

One of the lessons learned from the events at Fukushima Dai-ichi was the significance of the challenge presented by a loss of safety-related systems following the occurrence of a beyond-design-basis external event. In the case of Fukushima Dai-ichi, operators were distracted due to concerns associated with spent fuel pool cooling and potential loss of pool integrity, and this distraction adversely impacted mitigation efforts. The wide-range spent fuel pool level instrumentation required by 10 CFR 50.155(e) is intended to avoid such distraction and enable effective prioritization of event mitigation resources and recovery actions.

As one method of addressing these challenges, this RG endorses the guidance in NEI 12-02, Revision 1, with some clarifications and exceptions, as an acceptable method for use by licensees to demonstrate compliance with 10 CFR 50.155(e).

Background

Following the March 11, 2011 events at the Fukushima Dai-ichi nuclear power plant, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF undertook a systematic and methodical review of the NRC regulations and processes to determine if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 (Ref. 6). The Commission then directed the NRC staff in staff requirements memorandum (SRM) for SECY-11-0093 to identify any actions that could, and in the staff's judgment should, be taken in the near term considering the wide range of tools available. The staff's response to this Commission direction is contained in SECY-11-0124, "Recommended Actions To Be Taken without Delay from the Near-Term Task Force Report," dated September 9, 2011 (Ref. 7). Further, in SRM-SECY-11-0093, the Commission directed that all the regulatory actions in the NTTF report should be prioritized, and SECY-11-0137, "Prioritization of Recommended Actions To Be Taken in Response to Fukushima Lessons Learned," dated October 3, 2012 (Ref. 8), provides the staff's response to this direction.

As discussed in the SRM for SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami" (Ref. 9), dated March 9, 2012, the Commission determined that the additional requirements originally contained in Order EA-12-051 represent "...a significant enhancement to the protection of public health and safety and is an appropriate response to the insights from the Fukushima Dai-ichi accident." The Commission decided that it did not have sufficient information at the time to complete a full backfit analysis of the wide-range spent fuel pool level instrumentation that would be required by the Order. Therefore, the Commission decided to administratively exempt this Order from applicable provisions of 10 CFR 50.109, "Backfitting," and the issue finality requirements in 10 CFR Part 52.

Numerous public meetings were held to receive stakeholder input on the NTTF recommendation associated with enhanced SFP instrumentation both before and after the issuance of Order EA-12-051. On May 31, 2012, NEI submitted NEI 12-02, Revision B (Ref. 10), for review by the NRC staff. In response to comments from the NRC staff and the public, NEI revised the guidance document and submitted Revision 1 of NEI 12-02 in August 2012. The NRC staff has reviewed NEI 12-02, Revision 1, dated

August 2012 and endorses it, with some clarifications and exceptions, as an acceptable method for demonstrating compliance with the regulations in 10 CFR 50.155(e).

The regulation in 10 CFR 50.155(e) makes the requirements of NRC Order EA-12-051 generically applicable. This regulation, in order to support effective prioritization of event mitigation and recovery actions, requires each licensee to provide reliable means to remotely monitor wide-range water level for each spent fuel pool at its site until five years have elapsed since all of the fuel within that spent fuel pool was last used in a reactor vessel for power operation. The SFP level instrumentation at nuclear power plants in the United States prior to compliance with NRC Order EA-12-051 was typically narrow range and, therefore, only capable of monitoring normal and slightly off-normal conditions. The staff's review of the events at Fukushima Dai-ichi showed the benefits that can be derived from the availability of more diverse instrumentation. Reliable and available indication is essential to ensure plant personnel can effectively prioritize emergency actions between those addressing the needs of the fuel in the reactor vessel and those addressing the needs of fuel in spent fuel pools during and after extreme natural events.

Harmonization with International Standards

The International Atomic Energy Agency (IAEA) has established a series of technical reports, safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA guides present international good practices and identify best practices to help users striving to achieve high levels of safety. As part of their response to the events at Fukushima Dai-ichi, the IAEA prepared a technical report titled "Accident Monitoring Systems for Nuclear Power Plants," dated February 2015 (Ref. 11). This RG and NEI 12-02, Revision 1, contain guidance about accident monitoring and response systems similar to the discussion in the IAEA technical report.

Documents Discussed in Staff Regulatory Guidance

This RG endorses, in part, the use of one or more codes, standards, or guidance documents developed by external organizations. These codes, standards and third-party guidance documents 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 an 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 an 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.

C. STAFF REGULATORY GUIDANCE

This RG endorses, with the exceptions and clarifications identified in this section, the methods described in NEI 12-02, Revision 1, dated August 2012. The NRC staff has determined that the methods described in the NEI document constitute procedures and processes generally acceptable to the NRC staff for demonstrating compliance with the regulatory requirements for reliable wide-range SFP instrumentation in 10 CFR 50.155.

1. Introduction

Section 1 of NEI 12-02, Revision 1 provides a brief history of the events at Fukushima Dai-ichi nuclear power plant and the issuing of NRC Order EA-12-051 for reliable, wide-range SFP instrumentation.

2. Levels of Required Monitoring

Section 2 of NEI 12-02, Revision 1 describes the 3 critical levels in the SFP that must be monitored to demonstrate compliance with the regulations.

Staff Position: Section 2 of NEI 12-02, Revision 1 provides an acceptable monitoring approach for meeting 10 CFR 50.155(e).

3. Instrumentation Design Features

Section 3 of NEI 12-02, Revision 1 describes the types of instruments that can be used to monitor the SFP water level, their arrangement, mounting, qualification, accuracy, and testing.

Staff Position: Section 3 provides an acceptable approach regarding the types of instruments that can be used for monitoring as required by 10 CFR 50.155(e) with the following exceptions and clarifications for Section 3.4, “Qualification” of NEI 12-02, Revision 1:

3.1 Qualification - Guidance

The second bullet under subheading “Guidance” states that “*instrument channel reliability shall be demonstrated...*” for the “*effects of shock and vibration on instrument channel components used during any applicable event for only installed components....*”

Staff Position: The demonstration of reliability applies to the “effects of shock and vibration on instrument channel components used during and following any applicable event for installed components.”

Regardless of plant design basis, components of the instrument channels should be qualified for shock and vibration using one or more of the following methods:

- components are supplied by manufacturers using commercial quality programs (such as ISO 9001, “Quality Management Systems - Requirements” (Ref. 12)) with shock and vibration requirements included in the purchase specification at levels commensurate with portable hand-held device or transportation applications;

- components have a substantial history of operational reliability in environments with significant shock and vibration loading, such as portable hand-held device or transportation applications; or
- components are inherently resistant to shock and vibration loadings, such as cables.

Instrument channel reliability should be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the effects of shock and vibration on all instrument channel components, rather than only installed components. This exception is needed to strengthen the guidance in NEI 12-02, Revision 1 by recommending that portable instrument channel components should be designed as hand-held devices (e.g., commercially available smartphones) or similar rugged components. Additionally, this clarification is intended to remove the potential confusion regarding the extent of design basis shock and vibration loadings that may be different from the design basis seismic loadings.

The paragraph after the third bullet under the subheading “Guidance” in section 3.4 of NEI 12-02 states, in part, “*Readily available commercial components shall be considered.*” (emphasis added)

Staff Position: Commercial components may be considered, but the licensee may consider using augmented quality components, up to and including the quality and capability of components typically used in safety-related applications.

3.2 Qualification – Seismic

The first bullet under the section “Seismic” in section 3.4 of NEI 12-02 makes a provision for “...*instrument channel components... supplied by manufacturers with commercial quality programs... with seismic requirements... and commercial design and testing for operation in environments where significant seismic effects are common.*”

Staff Position: The guidance in this clause does not adequately address seismic levels and frequencies seen at the installation location or methods for demonstration. Demonstration of seismic motion consistent with that of existing design basis loads at the installed location is adequate. Quality programs are addressed in Appendix A-1 of NEI 12-02, Revision 1.

The second bullet under the subheading “Seismic” in section 3.4 of NEI 12-02 makes a provision for demonstrating adequacy of design and installation to account for seismic effects that includes “...*substantial history of operational reliability in environments with significant vibration.*”

Staff Position: Typically, vibration is an effect that occurs at higher frequency and lower amplitude than that of seismic motion. Consequently, seismic design and installation adequacy cannot be reasonably demonstrated solely through operational history of performance of components when subjected to vibration. The effects of low frequency, high acceleration need to be included in any demonstration of seismic design adequacy. This clause is not appropriate without stating that such a vibration design envelope shall be inclusive of the effects of seismic motion imparted to the components proposed at the location of the proposed installation.

The third bullet under the section “Seismic” lists four methods of demonstrating reliability.

Staff Position: The adequacy of seismic design and installation should be demonstrated based on the guidance in Sections 7, 8, 9, and 10 of the Institute of Electrical and Electronics Engineers

(IEEE) Standard 344-2004 or a substantially similar industrial standard. The use of IEEE Standard 344-2004 is endorsed by RG 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants" (Ref. 13).

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees¹ may use this guide and information regarding the NRC's plans for using this RG. In addition, it describes how the NRC staff complies with 10 CFR 50.109 and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily² use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this RG may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations.

Licensees may use the information in this RG for actions that do not require NRC review and approval. Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this RG. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this RG. The NRC staff does not expect or plan to request licensees to voluntarily adopt this RG to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action that would require the use of this RG without further backfitting or forward fitting consideration. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the RG, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this RG, generic communications, or a rule requiring the use of this RG.

During regulatory discussions on plant-specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this RG, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting. However, unless the facility license requires use of this RG, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this RG constitutes a violation.

If a licensee believes that the NRC is either using this RG or requesting or requiring the licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, "Backfitting Guidelines" (Ref. 14), and the NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection" (Ref. 15).

1 In this section, "licensees" refers to holders of, and "applicants" refers to applicants for, the following: (1) licenses for nuclear power plants under 10 CFR Parts 50 and 52; and (2) construction permits for nuclear power plants under 10 CFR Part 50.

2 In this section, "voluntary" and "voluntarily" means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

REFERENCES³

1. *U.S. Code of Federal Regulations (CFR)*, Title 10, “Energy,” Part 50, “Domestic Licensing of Production and Utilization Facilities.”
2. Nuclear Energy Institute (NEI) document NEI 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, ‘To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation’,” Revision 1, dated August 2012, Washington, DC. (ADAMS Accession No. ML12240A307)⁴
3. CFR, Title 10, “Energy,” Part 52, “Licenses, Certifications, and Approvals of Nuclear Power Plants.”
4. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.226 “Flexible Mitigation Strategies for Beyond-Design-Basis Events,” Washington, DC.
5. NEI document NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” Revision 3, dated September 22, 2016, Washington, DC. (ADAMS Accession No. ML16267A274).
6. NRC, SECY-11-0093, “Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” dated July 12, 2011, Washington, DC. (ADAMS Accession No. ML11186A950).
7. NRC, SECY-11-0124, “Recommended Actions to be Taken without Delay from the Near-Term Task Force Report,” dated September 9, 2011, Washington, DC. (ADAMS Accession No. ML11245A158).
8. NRC, SECY-11-0137, “Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,” dated October 3, 2011, Washington, DC. (ADAMS Accession No. ML11272A111).
9. NRC, SRM-SECY-12-0025, “Staff Requirements - SECY-12-0025 - Proposed Orders and Requests for Information in Response to Lessons Learned from Japan’s March 11, 2011, Great Tohoku Earthquake and Tsunami,” dated March 9, 2012, Washington, DC. (ADAMS Accession No. ML120690347).
10. NEI, document NEI 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, ‘To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation’,” Revision B, dated May 11, 2012, Washington, DC. (ADAMS Accession No. ML12135A414).

3 Publicly available documents from the NRC are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/>. The documents can also be viewed on-line for free or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail pdr.resource@nrc.gov.

4 Publications from the Nuclear Energy Institute (NEI) are available at their Web site: <http://www.nei.org/> or by contacting the headquarters at Nuclear Energy Institute, 1776 I Street NW, Washington DC 20006-3708, telephone: 202-739-8000, fax 202-785-4019.

11. International Atomic Energy Agency (IAEA), IAEA Technical Report No. NP-T-3.16, “Accident Monitoring Systems for Nuclear Power Plants,” dated February 2015, Vienna, Austria,⁵
12. International Organization for Standardization (ISO), ISO 9001, “Quality Management Systems – Requirements,” Geneva, Switzerland.⁶
13. NRC, RG 1.100, “Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants,” Washington, DC.
14. NRC, NUREG-1409, “Backfitting Guidelines,” Washington, DC.
15. NRC, Management Directive 8.4, “Management of Facility specific Backfitting and Information Collection,” Washington, DC.

5 Copies of International Atomic Energy Agency documents may be obtained through its Web site: <http://www.iaea.org/> or by writing the International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A-1400, Vienna, Austria.

6 Copies of International Organization for Standardization (ISO) documents may be obtained by writing to the International Organization for Standardization, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, telephone: +41 22 749 01 11, fax: +41 22 749 09 47, e-mail at customerservice@iso.org, or on-line at the ISO Store Web site: <http://www.iso.org/store.html>.