U.S. NUCLEAR REGULATORY COMMISSION

DRAFT REGULATORY GUIDE DG-1401

Proposed Revision 4 to Regulatory Guide 1.129

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MAINTENANCE, TESTING, AND REPLACEMENT OF VENTED LEAD-ACID STORAGE BATTERIES FOR PRODUCTION AND UTILIZATION FACILITIES

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes methods and procedures that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in complying with the agency's regulations with regard to the maintenance, testing, and replacement of vented lead-acid storage batteries in production and utilization facilities. This revision of RG 1.129 endorses (with certain clarifying regulatory positions described in Section C of this guide) Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 450-2020, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications" (Ref. 1).

Applicability

This RG applies to applicants and licensees subject to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 2), and 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 applicants for and holders of a license, as defined in 10 CFR 50.2. With respect to 10 CFR Part 52, this RG applies to applicants for and holders of licenses, as defined in 10 CFR 52.1, standard design certifications, and standard design approvals.

Applicable Regulations

The General Design Criteria (GDC) in Appendix A to 10 CFR Part 50 establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission. The GDC are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing the principal design criteria for such other units. The following GDCs are related to vented lead-acid storage batteries:

This RG is being issued in draft form to involve the public in the development of regulatory guidance in this area. It has not received final staff review or approval and does not represent an NRC final staff position. Public comments are being solicited on this DG and its associated regulatory analysis. Comments should be accompanied by appropriate supporting data. Comments may be submitted through the Federal rulemaking Web site, http://www.regulations.gov, by searching for draft regulatory guide DG-1401. Alternatively, comments may be submitted to the Office of Administration, Mailstop: TWFN 7A-06M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, ATTN: Program Management, Announcements and Editing Staff. Comments must be submitted by the date indicated in the *Federal Register* notice.

Electronic copies of this DG, previous versions of DGs, 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 https://www.nrc.gov/reading-rm/doc-collections/reg-guides/. The DG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML22026A441. The regulatory analysis may be found in ADAMS under Accession No. ML22026A443.

- GDC 1, "Quality Standards and Records," requires, in part, that structures, systems, and components (SSCs) important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

- GDC 4, "Environmental and dynamic effects design bases," requires in part that Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

- GDC 17, "Electric Power Systems," requires, in part, that an onsite electric power system and an offsite electric power system be provided to permit functioning of SSCs important to safety.

- GDC 18, "Inspection and Testing of Electric Power Systems," requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the conditions of their components.

Nuclear power plants and fuel reprocessing plants include structures, systems, and components that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 establishes quality assurance requirements for the design, manufacture, construction, and operation of those structures, systems, and components. The following quality assurance criteria are related to vented lead-acid storage batteries:

- Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, Criterion XI, "Test Control," sets forth the following requirements.

    - A test program shall be established to ensure that all testing is required to demonstrate that SSCs will perform satisfactorily in service and is identified and performed in accordance with written test procedures that incorporate the requirements and acceptance limits contained in applicable design documents.

    - The test program shall include, as appropriate, proof tests before installation, preoperational tests, and operational tests during nuclear power plant or fuel reprocessing plant operation of SSCs.

    - Test procedures shall include provisions for ensuring that all prerequisites for the given test have been met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions.

    - Test results shall be documented and evaluated to ensure that test requirements have been satisfied.

- Appendix B to 10 CFR Part 50, Criterion XII, "Control of Measuring and Test Equipment," sets forth the following requirement.

    - Measures shall be established to ensure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits.

10 CFR Part 52 requires that SSCs important to safety in a nuclear power plant be designed to accommodate the effects of environmental conditions and that design control measures, such as testing, be used to check the adequacy of the design

Related Guidance

- NUREG/CR-7148, "Confirmatory Battery Testing: The Use of Float Current Monitoring to Determine Battery State-of-Charge," issued November 2012 (Ref. 4), provides information on confirmatory battery testing; specifically, the use of float current monitoring to determine battery state-of-charge.

- The Model Application for Plant-Specific Adoption of Technical Specification Task Force (TSTF) Traveler TSTF-500, Revision 2, "DC Electrical Rewrite—Update to TSTF-360," issued September 2009 (Ref. 5), provides model technical specifications to verify the capability of batteries used in nuclear power plants.

- NUREG-1537, Parts 1 and 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," issued February 1996 (Ref. 6), contains format and content guidance for non-power reactor applicants and licensees, as well as a standard review plan and acceptance criteria for NRC staff.

- "Final Interim Staff Guidance Augmenting NUREG-1537, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Parts 1 and 2', for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," issued October 2012 (Ref. 7), contains format and content guidance for non-power aqueous homogeneous reactor and radioisotope production facility applicants and licensees, as well as a standard review plan and acceptance criteria for the NRC staff.

- "Endorsement of Appendix A to Oak Ridge National Laboratory Report, 'Proposed Guidance For Preparing and Reviewing A Molten Salt Non-Power Reactor Application,' as Guidance for Preparing Applications for the Licensing of Non-Power Liquid Fueled Molten Salt Reactors," dated November 18, 2020, (Ref. 8) which endorses with clarifications, "Proposed Guidance for Preparing and Reviewing a Molten Salt Non-Power Reactor Application" (ORNL/TM-2020/1478) to support the review of non-power molten salt reactors (Ref. 9).

- RG 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," (Ref. 10).

- RG 1.212, "Sizing of Large Lead-Acid Storage Batteries," (Ref. 11).

- RG 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors," (Ref. 12) provides guidance for developing principal design criteria for non-light water reactors.

Purpose of Regulatory Guides

The NRC issues RGs to describe methods that are acceptable to the staff for implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific issues or postulated events, and to provide guidance to applicants. RGs are not NRC regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs are

acceptable if supported by a basis 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 Part 50 and 10 CFR Part 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), under control numbers 3150-0011 and 3150-0151 respectively. Send comments regarding this information collection to the FOIA, Library, and Information Collections 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 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 Revision

The NRC issued RG 1.129, Revision 3, in September 2013, to endorse (with certain clarifying regulatory positions) IEEE Std. 450-2010 (Ref. 13). Since then, IEEE has revised the standard as IEEE Std. 450-2020 to provide clarifying guidance on maintenance, testing, and corrective actions. The revised IEEE standard also provides guidance for the condition monitoring of stationary batteries. The staff determined that the revised IEEE standard, subject to the conditions below, supports applications for new licenses, design certifications, standard design approvals, and license amendments.

Background

This RG provides guidance to manage vented lead-acid battery degradation such that a battery in service would retain its readiness for supporting design-basis events. It endorses, with certain clarifying regulatory positions, IEEE Std. 450-2020. The IEEE Power Engineering Society Energy Storage and Stationary Battery Committee developed this standard, and the IEEE Standards Association Standards Board approved it on December 3, 2020. IEEE Std. 450-2020 provides the recommended maintenance, test schedules, and testing procedures intended to optimize the life and performance of permanently installed vented lead-acid storage batteries used for standby power applications. It also provides guidance to determine when batteries should be replaced. IEEE Std. 450-2020 applies to full-float stationary applications in which a battery charger normally maintains the battery fully charged and supplies the direct current (DC) loads. However, specific applications, such as emergency lighting units, semiportable equipment, and alternate energy applications, may have other appropriate practices that are beyond the scope of the recommended practice. This standard does not include any other components of the DC system, and it does not require inspection and testing of the DC system even though the battery is part of that system.

IEEE Std. 450-2020 is an updated consensus standard that adds new recommendations, as well as informative annexes, which reflect the current state of technology for vented lead-acid batteries. In addition, RG 1.128 relates to installation of vented lead-acid storage batteries, and RG 1.212 relates to sizing of large lead-acid storage batteries.

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 Requirements 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 pursuant to the Commission's International Policy Statement (Ref. 14) and Management Directive and Handbook 6.6, "Regulatory Guides" (Ref. 15).

The Staff also considered IAEA Specific Safety Guide (SSG) No. SSG-34, "Design of Electrical Power Systems for Nuclear Power Plants," issued August 2016 (Ref. 16) in the development and update of this RG.

Documents Discussed in Staff Regulatory Guidance

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

C. STAFF REGULATORY GUIDANCE

The staff finds that IEEE Std. 450-2020 provides methods for maintenance, testing, and replacement of vented lead-acid storage batteries for stationary applications that are acceptable for use in demonstrating compliance with GDC 1, GDC 4, GDC 17, GDC 18, 10 CFR Part 50, Appendix B, Criteria XI and XII, and applicable regulations in 10 CFR Part 52 as they relate to testing the operability and functional performance of the components of large lead-acid storage battery systems, subject to the following regulatory positions:

1. Section 2, "Normative References," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

   RG 1.32, "Criteria for Power Systems for Nuclear Power Plants" (Ref. 17).

2. Section 3.1, "Definitions," of the IEEE Std. 450-2020 recommended practices should be replaced with the following:

   Critical period: That portion of the duty cycle that is the most severe and/or the specified time period of the battery duty cycle that is most severe.

   This critical period could be during the period of maximum current and/or during the most challenging period of the duty cycle identified during sizing of the battery, in accordance with RG 1.212.

3. Section 5.2.1, "Inspections," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

   For safety-related or Class 1E batteries, battery float current and voltage should be measured and recorded weekly. Where reference is made to the pilot cell, when using float current monitoring to indicate a fully charged condition, the pilot cell should be based on the lowest voltage cell(s) in the battery, and the frequency of specific gravity measurements should be reduced so as to not over-sample the cell(s). When using specific gravity measurements to indicate a fully charged condition, the pilot cell(s) should have an individual cell voltage (ICV) equal to the average of all ICVs of the battery to allow for rotating pilot cells annually so that no one cell is over-sampled.

4. Section 5.4.2, "State-of-Charge Indicator," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

   For safety-related or Class 1E batteries, the manufacturer should be consulted in determining the appropriate current monitoring method, voltage level, charging current range, and charge duration to ensure optimal battery performance. Also, vendor recommendations may be considered for determining these parameters.

5. Section 5.5, "Float Current Indications and Interpretations," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

   For safety-related or Class 1E batteries, the use of stabilized charging current or the three-time constant method described in NUREG/CR-7148 to determine a fully charged condition should be limited to lead-calcium batteries, and the use of stabilized charging

current should be verified by measurement during charging. As there is wide variation in the initial and end charging currents, the instrumentation used to measure charging currents should have the appropriate range and sensitivity.

6. Section 6, "Test Schedule," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

> For safety-related or Class 1E batteries, when the battery service test discussed in Section 6.4, "Service," and described in Section 7.6, "Service Test," and the battery performance test discussed in Section 6.3, "Performance," and described in Section 7.4, "Capacity Test Methods," are scheduled to be performed in the same year, both tests should be performed. The battery service test should be performed every refuel outage and should not exceed 24 months.

7. Section 6.5, "Modified Performance Test," of the IEEE Std. 450-2020 recommended practices now state, in the last paragraph, that a modified performance test can be used in lieu of a service test and/or a performance test at any time. If the battery has been sized in accordance with RG 1.212, which endorses IEEE Std. 485, then the battery is acceptable if it delivers a tested capacity of 80 percent or greater. This statement should be replaced with the following:

> A modified performance test can be used in lieu of a service test and/or a performance test when the service and/or performance tests are scheduled to be performed. The modified performance test should follow the "Rules for Modified Performance Tests" in Annex I, "Modified Performance Testing Methods and Examples," to IEEE Std. 450-2020.

If the battery has been sized in accordance with RG 1.212, which endorses IEEE Std. 485, the battery is acceptable if (1) it delivers a tested capacity of greater than 80 percent, and (2) there are no indications of degradation as stated in Section 6.3 of IEEE Std. 450-2020. The modified performance test/service test should be performed with intervals not to exceed 24 months. However, when modified performance test/service test results show that the battery has degraded or has reached 85 percent of its expected service life with a capacity lower than 100 percent of the manufacturer's rating, modified performance testing should be performed on an annual basis.

8. Section 7.7, "Restoration," of the IEEE Std. 450-2020 recommended practices should be supplemented with the following:

> Following the recharge and before returning the battery to service, record the float voltage of each cell of the string.

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. 18), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." 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 regulatory guide 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 [1]

1. Institute of Electrical and Electronic Engineers (IEEE) Std. 450-2020, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications," Piscataway, NJ. [2]

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. U.S. Nuclear Regulatory Commission (NRC), NUREG/CR-7148, "Confirmatory Battery Testing: The Use of Float Current Monitoring to Determine Battery State-of-Charge," Washington, DC, November 2012. (ADAMS Accession No. ML12313A413)

5. Technical Specifications Task Force (TSTF)—A Joint Owners Group, TSTF-500, "DC Electrical Rewrite—Update to TSTF-360," Revision 2, Rockville, MD, September 2009. (ML092670242)

6. NRC, NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," Washington, DC, February 1996. (ML042430055 and ML042430048)

7. NRC, "Final Interim Staff Guidance Augmenting NUREG-1537, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," Washington, DC. (ML12156A069 and ML12156A075)

8. NRC, "Endorsement of Appendix A to Oak Ridge National Laboratory Report, 'Proposed Guidance For Preparing and Reviewing A Molten Salt Non-Power Reactor Application,' as Guidance for Preparing Applications for the Licensing of Non-Power Liquid Fueled Molten Salt Reactors," Washington, DC. (ML20251A008)

9. Oak Ridge National Laboratory, ORNL/TM-2020/1478, "Proposed Guidance for Preparing and Reviewing a Molten Salt Non-Power Reactor Application, Oak Ridge, TN. (ML20219A771)

10. NRC, RG 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," Washington, DC.

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1 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 on line 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.

2 Copies of Institute of Electrical and Electronics Engineers (IEEE) documents may be purchased from the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855 or through the IEEE's public Web site at http://www.ieee.org/publications_standards/index.html.

11. NRC, RG 1.212, "Sizing of Large Lead-Acid Storage Batteries," Washington, DC.

12. NRC, RG 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors," Washington, DC.

13. IEEE Standard 450-2010, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications," Piscataway, NJ.

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

15. NRC, Management Directive and Handbook 6.6, "Regulatory Guides," Washington, DC.

16. International Atomic Energy Agency, Specific Safety Guide (SSG) No. SSG-34, "Design of Electrical Power Systems for Nuclear Power Plants," Vienna, Austria, August 2016.[3]

17. NRC, RG 1.32, "Criteria for Power Systems for Nuclear Power Generating Systems," Washington, DC.

18. NRC, Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," Washington, DC.

3 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.