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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1155

(Proposed Revision 2 of Regulatory Guide 1.129, dated February 1978)

MAINTENANCE, TESTING, AND REPLACEMENT OF VENTED LEAD-ACID STORAGE BATTERIES FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) developed this regulatory guide to describe a method that the NRC staff 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 nuclear power plants. Specifically, the method described in this regulatory guide relates to General Design Criteria (GDCs) 1, 17, and 18, as set forth in Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10, Part 50, of the *Code of Federal Regulations* (10 CFR Part 50), "Domestic Licensing of Production and Utilization Facilities":

- GDC 1, "Quality Standards and Records," requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.
- GDC 17, "Electric Power Systems," requires that an onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety.
- GDC 18, "Inspection and Testing of Electric Power Systems," requires that electric power systems important to safety shall 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 condition of their components.

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

- A test program shall be established to ensure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service.
- The test program shall be identified and performed in accordance with written test procedures, which incorporate the requirements and acceptance limits contained in applicable design documents.
- The program shall include, as appropriate, proof tests prior to the installation, preoperational tests, and operational tests during nuclear power plant or fuel reprocessing plant operation, of structures, systems and components.
- Test procedures shall include provisions for ensuring that all prerequisites for the given test have been met, adequate test instrumentation is available and used, and the test is performed under suitable environmental conditions.
- Test results shall be documented and evaluated to ensure that test requirements have been satisfied.

To augment those requirements, Criterion XII, "Control of Measuring and Test Equipment," in Appendix B to 10 CFR Part 50 sets forth the following requirements:

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

This proposed Revision 2 of Regulatory Guide 1.129 endorses (with certain clarifying regulatory positions described in Section C of this guide) the "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications," which the Institute of Electrical and Electronics Engineers (IEEE) published as IEEE Std 450-2002[1]. By contrast, Revision 1 of Regulatory Guide 1.129, dated February 1978, currently endorses (with certain clarifying regulatory positions described in Section C) IEEE Std 450-1975, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Lead Batteries for Generating Stations and Substations."

This revised regulatory guide is intended for licensees of new nuclear power plants.[2] Previous revisions of this regulatory guide remain in effect for licensees of current operating reactors,[2] who are unaffected by this proposed revision. However, licensees of current operating reactors may voluntarily convert their battery maintenance, testing, and replacement criteria to the criteria in this revised guide.

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[1] IEEE publications may be purchased from the IEEE Service Center, which is located at 445 Hoes Lane, Piscataway, NJ 08855 [http://www.ieee.org, phone (800) 678-4333].

[2] The terms "new nuclear power plant" and "new plant" refer to any nuclear power plant for which the licensee obtained an operating license after the NRC issued Revision 2 of Regulatory Guide 1.129. The terms "current operating reactor" and "current plant" refer to any nuclear power plant for which the licensee obtained an operating license before the NRC issued Revision 2 of Regulatory Guide 1.129.

The NRC issues regulatory guides 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 accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required. The NRC issues regulatory guides in draft form to solicit public comment and involve the public in developing the agency's regulatory positions. Draft regulatory guides have not received complete staff review and, therefore, they do not represent official NRC staff positions.

This regulatory guide contains information collections, covered by the requirements of 10 CFR Part 50, that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

IEEE Std 450-2002, was developed by the IEEE Standard 450 Working Group, Maintenance and Testing Subcommittee of the Power Engineering Society Stationary Battery Committee (Standards Coordinating Committee 29), and was approved by the IEEE-SA Standards Board on December 9, 2002. IEEE Std 450-2002 provides the recommended maintenance, test schedules, and testing procedures that can be used 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. This recommended practice applies to full-float stationary applications, where a battery charger normally maintains the battery fully charged and provides 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 recommended practice does not include any other components of the dc system, or inspection and testing of the dc system, even though the battery is part of that system, and does not specifically address Class 1E batteries in nuclear generating stations.

In comparison to IEEE Std 450-1975, IEEE Std 450-2002 is an updated national consensus standard that adds new recommendations and requirements, as well as informative annexes that reflect the current state of technology for vented lead-acid batteries. It is important to recognize that IEEE Std 450-2002 states that it shall be used in conjunction with IEEE Std 485-1997, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications." Consequently, some of the criteria in IEEE Std 450-2002 (such as the test acceptance criteria) depend on having sized the batteries in accordance with IEEE Std 485-1997. For example, the battery replacement criteria in IEEE Std 450-2002 are based on IEEE Std 485-1997, which recommends that the batteries be replaced when their actual performance drops below 80 percent of their rated performance. Consequently, IEEE Std 485-1997 recommends that to ensure that the batteries are capable of meeting their design loads throughout their service life, the batteries' rated capacity should be 125 percent (1.25 aging factor) of the load expected at the end of their service life.

IEEE Std 450-2002 also introduces the use of stabilized charging current to determine a fully charged condition. The information in IEEE Std 450-2002 indicates that after battery discharge, the recharge current is initially high (typically for a few hours), but rapidly decreases to a relatively constant value as the battery voltage approaches the charger voltage. When the charging current stabilizes at the charging voltage for three consecutive hourly measurements, the battery is near full charge. IEEE Std 450-2002 also states that some methods to determine the state of charge are better suited than others for some battery cell plate metallurgies. Specifically, using stabilized charging current to determine a fully charged condition is the recommended practice for lead-calcium batteries, and using electrolyte-specific gravity and battery float voltage measurement readings is the recommended practice for lead-antimony batteries. The manufacturer should be consulted for the recommended charging method, as well as for the charging current and voltage parameters.

IEEE Std 450-2002 also introduces the use of a modified performance test in lieu of a service test and/or a performance test. A service test is a periodic test of the as-found condition of a battery to meet its duty cycle, and its results reflect the effectiveness of maintenance practices. A performance test is a periodic test of the battery capacity, and its results are used to trend battery aging and to determine when the battery needs to be replaced. By contrast, a modified performance test is a test of the battery capacity with the discharge rate modified according to the rules in an informative annex of IEEE Std 450-2002. These rules ensure that the modified performance testing is of sufficient magnitude and duration to envelop every portion of the battery duty cycle, the service test, and the performance test. For best trending results, the same test methods should be used throughout the battery life. Notably, the regulatory position in Revision 1 of Regulatory Guide 1.129 stated that both the performance and service tests should be performed, and the service test should be performed with a typically expected refueling cycle.

In addition, IEEE Std 450-2002 introduces the practice of allowing users to transition from correcting for temperature before conducting the discharge test to correcting for temperature after conducting the discharge tests. However, the standard does not provide any supportive information to evaluate the impact of this practice.

The NRC has developed this proposed Revision 2 of Regulatory Guide 1.129 to (1) carry forward the regulatory position from Revision 1, and (2) develop regulatory positions based on the review of the differences between IEEE Std 450-1975 and IEEE Std 450-2002, with consideration of Class 1E batteries used in nuclear power generating stations.

C. REGULATORY POSITION

Conformance with the specifications of IEEE Std 450-2002 for maintenance, testing, and replacement of vented lead-acid storage batteries for stationary applications provides an adequate basis for complying with the requirements set forth in GDCs 1, 17, and 18 of Appendix A to 10 CFR Part 50, as well as Criterion III of Appendix B to 10 CFR Part 50, as they relate to testing the operability and functional performance of the components of large lead storage battery systems, subject to the following regulatory positions:

1. Subsection 2, "References," which stipulates that this standard should be used in conjunction with other IEEE standards, should be supplemented as follows:

   "This recommended practice shall be used in conjunction with the following publications:

   - IEEE Std 308, 'Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,' as endorsed by Regulatory Guide 1.32
   - IEEE Std 484, 'IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications (ANSI/BCI),' as endorsed by Regulatory Guide 1.128
   - IEEE Std 485-1997, 'IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications (BCI).'"

2. Subsection 5.2, "Inspections," should be supplemented with the following:

   "For nuclear power generating station Class 1E batteries, battery float current and voltage should be measured and recorded weekly."

3. Subsection 5.4.1, "State of Charge Indicator," should be supplemented with the following:

   "(c) For nuclear power generating stations, the manufacturer should be consulted for the proper voltage and charging current ranges and durations."

   "(d) For nuclear power generating station Class 1E batteries, the use of stabilized charging current to determine a fully charged condition should (1) be limited to lead-calcium batteries and (2) verified by measurements during charging. When it has been recorded that the charging current has stabilized at the charging voltage for three consecutive hourly measurements, the battery is near full charge. These measurements shall be made after the initially high charging current decreases sharply and the battery voltage rises to approach the charger output voltage. 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."

4. Subsection 6, "Test Schedule," should be supplemented with the following*:*

   "For nuclear power generating station Class 1E batteries, the battery service test discussed in Subsection 6.3, 'Service,' and described in Subsection 7.5, 'Service Test,' should be performed in addition to the battery performance test described in Subsection 6.2, 'Performance.' The battery service test should be performed with intervals not to exceed 24 months."

5. In Subsection 6.1, "Acceptance test," a second sentence should be added to state as follows:

   "However, a test of the battery's capability (see 7.5) shall be made upon initial installation."

6. In Subsection 6.4, "Modified performance test," the last paragraph states that a modified performance test can be used in lieu of a service test and/or a performance test at any time, and if the battery has been sized in accordance with IEEE Std 485-1997, it is acceptable if it delivers a tested capacity of 80 percent. This statement should be replaced with the following:

   "For nuclear power generating station Class 1E batteries, a modified performance test can be used in lieu of a service test and/or a performance test at any time. However, it is preferred that the same test method be used throughout the battery life. The modified performance test should follow the 'Rules for Modified Performance Tests' in Annex I, 'Modified Performance Testing Methods and Examples,' of IEEE Std 450-2002. If the battery has been sized in accordance IEEE Std 485-1997, the battery is acceptable if (1) it delivers a tested capacity of greater than 80 percent, and (2) there is no indication of degradation as indicated in Subsection 6.2(c) of IEEE Std 450-2002. The modified performance test should be performed with intervals not to exceed 24 months. However, when modified performance test results show that the battery has degraded, or has reached 85% of the expected life with a capacity lower than 100% of the manufacturer's rating, modified performance testing should be performed on an annual basis."

7. In Subsection 7.2.2, "Discharge Rate," the last paragraph allows users to transition from correcting for temperature *before* conducting the discharge test to correcting for temperature *after* conducting the discharge test. This statement should be supplemented with the following:

   "For nuclear power generating station Class 1E batteries, the preferred method is to adjust the discharge rate for the time-adjusted method for temperature before conducting the test."

8. Annexes A through K are informative and provide optional test methods. Unless otherwise stated in a regulatory position, endorsement of IEEE Std 450-2002 does not include these annexes.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this draft regulatory guide. Because some areas of IEEE Std 450-2002 do not meet the NRC's regulatory requirements, this proposed Revision 2 of Regulatory Guide 1.129 (1) carries forward the regulatory position from Revision 1, and (2) sets forth regulatory positions based on the staff's review of the differences between IEEE Std 450-1975 and IEEE Std 450-2002, with consideration of vented lead-acid batteries used in nuclear power generating stations. No backfitting is intended or approved in connection with the issuance of this proposed revision.

The NRC has issued this draft guide to encourage public participation in its development. Except in those cases in which an applicant or licensee proposes or has previously established an acceptable alternative method for complying with specified portions of the NRC's regulations, the methods to be described in the active guide will reflect public comments and will be used in evaluating (1) submittals in connection with applications for construction permits, standard plant design certifications, operating licenses, early site permits, and combined licenses; and (2) submittals from operating reactor licensees who voluntarily propose to initiate changes involving the maintenance, testing, and replacement of vented lead-acid batteries.

REGULATORY ANALYSIS

1. Statement of the Problem

Revision 1 of Regulatory Guide 1.129, dated February 1978, currently endorses (with certain clarifying regulatory positions) IEEE Std 450-1975. By contrast, IEEE Std 450-2002, which the IEEE-SA Standards Board approved on December 9, 2002, is an updated national consensus standard that reflects the current state of technology. There is an immediate need to revise Regulatory Guide 1.129, as IEEE Std 450-2002 introduces several new technologies that could result in greater efficiencies for both new and currently operating reactors. IEEE Std 450-2002 introduces the application of stabilized charging current, rather than specific gravity, to determine a lead-calcium battery's state-of-charge. It also introduces a modified performance test that has been designed to envelop the traditional performance and service tests. Accordingly, the NRC's Office of Nuclear Reactor Regulation (NRR) has requested that the agency update the current regulatory guidance in Revision 1 of Regulatory Guide 1.129 based on the latest available information to support the licensing of new and currently operating reactors.

2. Technical Approach

In developing Revision 2 of Regulatory Guide 1.129, the NRC staff considered the following two alternative approaches:

(1) **Take no action.** IEEE Std 450-2002 has been updated to reflect the current state of technology, and it is already being used voluntarily by licensees of current operating reactors. Taking no action adds no value, as it leaves in place a regulatory guide that is based on a 31-year-old IEEE standard that does not reflect current technology. Moreover, without revised regulatory guidance, NRR will most likely require additional resources to evaluate the differences when applications for new reactors or licensing amendments for current operating reactors use the more recent revision. As a result, the staff did not select this approach.

(2) **Revise Regulatory Guide 1.129 to incorporate previous regulatory positions pertaining to this subject and endorse IEEE Std 450-2002 with clarifying exceptions as appropriate.** Revision 2 of Regulatory Guide 1.129 is intended for new plants. However, it is likely that new reactors and current operating reactors will voluntarily adopt this standard because of the effectiveness and efficiencies of the new technologies.

The NRC staff compared IEEE Std 450-2002 to IEEE Std 450-1975 to identify the changes to be evaluated with regard to their impact on safety and the regulatory positions in Revision 1 of Regulatory Guide 1.129.

3. Values and Impacts

In the following summary of values and impacts, an impact represents a "cost" in terms of schedule, budget, staffing, or an undesirable attribute that would accrue from taking the proposed approach.

3.1 Alternative 1: Take No Action

This alternative has a perceived cost benefit, in that IEEE Std 450-1975, as endorsed by Revision 1 of Regulatory Guide 1.129, has been in use for many years and is familiar to the industry. However, applicants for new reactors are not using IEEE Std 450-1975, and the industry has indicated a general interest in using IEEE Std 450-2002 for current operating reactors.

Value: None. Although the industry is familiar with Revision 1 of Regulatory Guide 1.129, which endorses IEEE Std 450-1975, new plants are using, and current operating reactors are likely to voluntarily adopt, IEEE Std 450-2002 because of the resulting efficiencies.

Impact: This alternative would incur schedule and staff costs to the NRC and applicants associated with evaluating case-by-case differences between IEEE Std 450-1975 (as endorsed by Revision 1 of Regulatory Guide 1.129) and, when used, IEEE Std 450-2002.

3.2 Alternative 2: Revise Regulatory Guide 1.129 to Incorporate the Previous Regulatory Positions Pertaining to This Subject and Endorse IEEE Std 450-2002 with Clarifying Exceptions as Appropriate

Value: IEEE Std 450-2002 reflects the current state of technology, which, if adopted for new or current operating reactors, will help to ensure compliance of battery maintenance, testing, and replacement with GDC 1, 17, and 18 (as set forth in Appendix A to 10 CFR Part 50) and Criteria III and XII (as set forth in Appendix B to 10 CFR Part 50).

Battery charging current, in accordance with clarifying regulatory positions, may be a more reliable indicator of the state-of-charge for lead-calcium batteries than specific gravity. The use of a modified performance test in lieu of performance and/or service tests neither adds nor detracts in value, as it envelops both tests and demonstrates the high rate capability of the battery to meet its duty cycle.

Impact: The regulatory position to add weekly measurements should generally have no impact, as it is consistent with typical nuclear generating station Technical Specification Surveillance Requirements.

The use of battery charging current and modified performance testing, in accordance with clarifying regulatory positions, should have a favorable impact. The use of stabilized charging current to determine the state of charge is expected to lead to remote battery monitoring and be significantly more efficient than the use of specific gravity. A single test takes less time and is more efficient than two tests.

Another benefit of utilizing the modified performance test in lieu of the service test is that it would provide more data points for trending the capacity of the battery.

Adjusting the discharge rate for the time-adjustment method for temperature before conducting the test is the current method and should have no impact.

The use of IEEE Std 485-1997 in conjunction with IEEE Std 450-2002 is implicit, and this should have no impact as IEEE Std 485-1997 is the general battery sizing criterion that has been used by the industry.

4. Conclusion

The staff recommends that the NRC issue Revision 2 of Regulatory Guide 1.129 to endorse IEEE Std 450-2002 as the recommended practice for the maintenance, testing, and replacement of vented lead-acid storage batteries for stationary applications. This action will enhance the licensing process for new nuclear power plants, while providing the flexibility for current operating reactors to adopt this guidance without cost impact.

BACKFIT ANALYSIS

This regulatory guide does not require a backfit analysis, as described in 10 CFR 50.109, "Backfitting," because it is intended for new nuclear power plants. The use of this revision by current operating licensees is entirely voluntary.