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OFFICE OF NUCLEAR REGULATORY RESEARCH

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INSTALLATION DESIGN AND INSTALLATION 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 satisfying criteria for the installation design and installation 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 III, "Design 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:

- Measures shall be established to assure that applicable regulatory requirements and the design basis, as defined in §50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies are correctly translated into specifications, drawings, procedures, and instructions.
- These measures shall include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled.
- The design control measures shall provide for verifying or checking the adequacy of design, such as by performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program.

This Revision 2 of Regulatory Guide 1.128 endorses (with certain clarifying regulatory positions described in Section C of this guide) the "IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications," which the Institute of Electrical and Electronics Engineers (IEEE) published as IEEE Std 484-2002.[1] By contrast, Revision 1 of Regulatory Guide 1.128, dated October 1978, endorsed (with certain clarifying regulatory positions described in Section C) IEEE Std 484-1975.

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 revision. However, licensees of current operating reactors may voluntarily convert their battery installation design and installation to the criteria in this revised guide.

This regulatory guide contains information collections that are covered by the requirements of 10 CFR Part 50, which 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.

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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 1.128. 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 1.128.

B. DISCUSSION

IEEE Std 484-2002, was developed by the IEEE Working Group on Vented Lead-Acid Battery Installation, Station Design Subcommittee of the Power Generation Committee, and was approved by the IEEE-SA Standards Board on September 12, 2002. IEEE Std 484-2002 provides the recommended design practice and procedures for storage, location, mounting, ventilation, instrumentation, pre-assembly, assembly, and charging of vented lead-acid batteries. As such, IEEE Std 484-2002 is applicable to full float stationary applications, in which a battery charger normally maintains the battery in a fully charged state and provides power to the direct current (dc) loads.

In comparison to IEEE Std 484-1975, which addresses large lead storage batteries, IEEE Std 484-2002 adds new recommendations and requirements, and incorporates some elements of the regulatory positions of Regulatory Guide 1.128, Revision 1. IEEE Std 484-2002 is generalized for stationary batteries for generating stations and substations and has been relaxed by deleting recommendations and requirements in IEEE Std 484-1975 specific to nuclear power generating stations. This standard eliminates the use of IEEE Standards 308, 336, 344, and 384, which provide additional recommendations and requirements related to the installation and tests upon installation of Class 1E batteries for nuclear power generating stations. It also deletes the requirement for a quality assurance program, reduces the requirement that the battery installation shall be protected against natural and induced phenomena (such protection is now presented as a recommendation). In addition, IEEE Std 484-2002 deletes separation requirements, and reduces the number of tests used to identify the pilot cell during the freshening charge. This standard also uses the applicable building codes for seismic protection, and deletes the requirement that the installation shall be able to withstand the force calculated for a safe shutdown earthquake to allow continuous battery service during such events as required by IEEE Std 344 and endorsed in the NRC's regulatory guidance.

Portions of IEEE Std 484-2002 continue to be directed toward recommendations in the area of battery room cleanliness and ventilation, temperature control, and fire prevention. Battery room cleanliness and ventilation are important because the battery chemistry for lead-acid storage batteries is sensitive to contaminants and temperatures above and below the manufacturer's rating. In addition, the batteries also release hydrogen (a potential fire hazard) to the battery room during charging. The NRC also has regulatory guidance for preventing fires in battery rooms; however, some of its elements (such as the value for the hydrogen accumulated limits, air flow sensors and alarms in the control room, and fire detection design features) are not recommended in this IEEE standard.

IEEE Std 484-2002 eliminates the IEEE Std 484-1975 recommendation that cells should be mounted in accordance with the manufacturer's recommended separation distance, and adds a mounting arrangement that eliminates the requirement that cell plates shall be able to be inspected. It is common practice to inspect battery cell plates for conditions that are known to result in degradation of battery performance, including excessive accumulation of lead sulfate, growth of the positive plates against the container, and evidence of excessive cell plate corrosion. In addition, the battery cells must be arranged on the racks to allow for inspection of cell plates.

This Revision 2 of Regulatory Guide 1.128 evaluates the new recommendations and requirements in IEEE Std 484-2002, with respect to their importance to safety. It also updates the regulatory positions in Revision 1 of Regulatory Guide 1.128 by (1) deleting those that have been incorporated into IEEE Std 484-2002; (2) adding a regulatory position to update and carry forward the use of other IEEE standards, recommendations, and requirements applicable to nuclear power generating station batteries, which were contained in IEEE Std 484-1975 but deleted in IEEE Std 484-2002; (3) updating and carrying forward the regulatory positions for preventing fires in battery rooms based on the current NRC guidance in Regulatory Guide 1.189, "Fire Protection for Operating Nuclear Power Plants"; and (4) updating and carrying forward past regulatory positions that took exception to IEEE Std 484.

C. REGULATORY POSITION

Conformance with the IEEE Std 484-2002 requirements (indicated by the verb "shall") for installation design and installation of vented lead-acid storage batteries for nuclear power plants provides an adequate basis for complying with the design, fabrication, erection, and testing 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, subject to the following stipulations:

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

   "For nuclear power generating stations, the recommended practice should also be used in conjunction with other pertinent publications. (In some cases, the specific applicability or acceptability of these documents may be covered separately in other regulatory guides.) The pertinent publications include the following IEEE standards:

   - IEEE Std 308, 'Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,' as endorsed by Regulatory Guide 1.32
   - IEEE Std 336-2005, 'Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control at Nuclear Facilities'
   - IEEE Std 344, 'Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,' as endorsed by Regulatory Guide 1.100
   - IEEE Std 450, 'Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications,' as endorsed by Regulatory Guide 1.129
   - IEEE Std 384, 'Standard Criteria for Independence of Class 1E Equipment and Circuits,' as endorsed by Regulatory Guide 1.75"

2. Subsection 5.1, "Location, " item (d) should be supplemented to add the following:

   "(d) For nuclear power generating stations, the general requirement that the battery should be protected against fires should be supplemented with the applicable recommendations for battery rooms in Regulatory Guide 1.189, 'Fire Protection for Operating Nuclear Power Plants.'"

3. Subsection 5.1, "Location," should be supplemented to add item (k), as follows:

   "(k) For nuclear power generating station Class 1E batteries, where batteries are required in redundant systems, the batteries shall be separated as specified by IEEE Std 384, 'Standard Criteria for Independence of Class 1E Equipment and Circuits,' and as recommended for battery rooms in Regulatory Guide 1.189, 'Fire Protection for Operating Nuclear Power Plants.'"

4. Subsection 5.2, "Mounting," item (c), should be supplemented to add the following:

   "(c) For nuclear power generating stations, battery cells must be arranged on racks to provide for the ability for cell plates to be inspected."

5. Subsection 5.3, "Seismic," criteria should be supplemented to add the following:

   "(d) For nuclear power generating station Class 1E batteries, the racks, anchors, and installation thereof shall be able to withstand the force calculated for a safe shutdown earthquake to allow continuous battery service during and following the event in accordance with IEEE Std 344, 'Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,' and the associated Regulatory Guide 1.100, 'Seismic Qualification of Electric Equipment for Nuclear Power Plants.'"

6. In Subsection 5.4, "Ventilation," revise the second sentence to be consistent with Regulatory Guide 1.189, as follows:

"The ventilation system shall limit hydrogen accumulation to one percent of the total volume of the battery area."

7. In Subsection 6.3.1, "Freshening Charge Sequence," item (a) should be supplemented as follows:

"(a) The pilot cell determined by sampling shall not be used to support maintenance and test measurements in IEEE Std 450 as endorsed by Regulatory Guide 1.129, unless that pilot cell has been verified through measurement of each cell's specific gravity and float voltage to be representative of the average of the entire battery."

8. Subsection 6.3.4, "Acceptance test," should be revised to specify capability and capacity tests upon initial installation, as follows:

"Upon initial installation, the battery's capability shall be demonstrated by completing a service test or modified performance test in accordance with IEEE Std 450, as endorsed by Regulatory Guide 1.129. If factory tests did not include capacity tests, the battery's capacity shall also be demonstrated by completing a performance test or modified performance test in accordance with IEEE Std 450, as endorsed by Regulatory Guide 1.129."

9. IEEE Std 484-2002 should be supplemented to add Section 8.0, as follows:

"8.0 Quality Assurance Program

For nuclear power generating stations, where the battery performs a Class 1E function, a quality assurance program shall be adopted to control and document all activities related to such functions."

10. In addition to the requirements of IEEE Std 484-2002, the recommendations (indicated by the verb "should") contained in the following sections of that standard have sufficient safety importance to be treated the same as the requirements of the standard:

    (a) Subsection 5.1, "Location," item (c) recommends that the battery area be clean, dry, and well-ventilated and provide adequate space and illumination for inspection, maintenance, testing, and cell/battery replacement.

    (b) Subsection 5.1, "Location," item (d) recommends that the battery be protected against natural phenomena, such as earthquakes, winds, and flooding, as well as induced phenomena, such as fire, explosion, missiles, pipe whips, discharging fluids, and carbon dioxide. In addition, the examples of induced phenomena are revised to add the following:

    "radiation."

    (c) Subsection 5.1, "Location," item (g), which recommends providing stationary water facilities for rinsing spillage, should be supplemented with the following:

    "Where portable or stationary water facilities are provided within the battery room, their design should preclude any inadvertent spilling of water from these facilities onto the battery itself."

(d) In Subsection 5.5, "Instrumentation and Alarms," the four listed items should be supplemented with two recommended items, as follows:

"(e) Ventilation air flow sensor(s) and alarm(s) in the control room"

"(f) Fire detection sensor(s), instrumentation, and alarm(s), as recommended for battery rooms in Regulatory Guide 1.189, 'Fire Protection for Operating Nuclear Power Plants'"

(e) Subsection 6.1.3, "Storage," item (a) recommends avoiding extremely low or high ambient temperatures or localized sources of heat.

(f) Subsection 6.3.2, "Data collection," is supplemented with the following:

"(e) At the completion of the freshening charge, a hydrogen survey shall be performed to verify that the design criteria required by Subsection 5.4, 'Ventilation,' are met (see Section 7, 'Records')."

(g) Subsection 7, "Records," is supplemented with the following:

"(f) Initial hydrogen survey data"

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide. No backfitting is intended or approved in connection with its issuance.

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 NRC staff will use the methods described in this guide to evaluate (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 installation design and installation of vented lead-acid storage batteries in nuclear power plants.

REGULATORY ANALYSIS / BACKFIT ANALYSIS

The regulatory analysis and backfit analysis for this regulatory guide are available in Draft Regulatory Guide DG-1154, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants."[3] The NRC issued DG-1154 in October 2006 to solicit public comment on the draft of this Revision 2 of Regulatory Guide 1.128.

[3] Draft Regulatory Guide DG-1154 is available electronically under Accession #ML062220170 in the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR), which is located at 11555 Rockville Pike, Rockville, Maryland; the PDR's mailing address is USNRC PDR, Washington, DC 20555-0001. The PDR can also be reached by telephone at (301) 415-4737 or (800) 397-4205, by fax at (301) 415-3548, and by email to PDR@nrc.gov.