DRAFT REGULATORY GUIDE DG-1154
(Proposed Revision 2 of Regulatory Guide 1.128, dated October 1978)
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":

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- 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 proposed 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 484-2002. By

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contrast, Revision 1 of Regulatory Guide 1.128, dated October 1978, currently endorses (with certain clarifying regulatory positions described in Section C) IEEE 484-1975.

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

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 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.

B. DISCUSSION

IEEE 484-2002, was developed by the 484 Working Group of the IEEE Power Engineering Society Stationary Battery Committee, (previously IEEE Standards Coordinating Committee SCC-29) and was approved by the IEEE-Standards Association Standards Board on September 12, 2002. **COMMENT: IEEE 484 is a recommended practice, not a standard. For consistency delete the abbreviation Std from all locations.** IEEE 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 484-2002 is applicable to full float stationary applications, in which a battery charger normally maintains the battery fully charged and provides the direct current (dc) loads.

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In comparison to IEEE 484-1975, which addresses large lead storage batteries, IEEE 484-2002 adds new recommendations and requirements, and incorporates some elements of the regulatory positions of Regulatory Guide 1.128, Revision 1. IEEE 484-2002 is generalized for stationary batteries for generating stations and substations and has been relaxed by deleting recommendations and requirements in IEEE 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 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

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addition, IEEE 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 344 and endorsed in the NRC's regulatory guidance.

Portions of IEEE 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 freshening, equalize and (minimal) float charging. The NRC also has regulatory guidance for preventing fires in battery rooms; however, not all of its elements are recommended in this IEEE standard.

IEEE 484-2002 eliminates the IEEE 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. Conformance to IEEE 450-2002 endorsed by Reg. Guide 1.129 Rev. 2 includes recommendations for periodic inspection of battery cell plates for conditions that are known to result in degradation of battery performance. To perform these inspections, the battery cells must be arranged on the racks to allow for inspection of cell plates.

This proposed Revision 2 of Regulatory Guide 1.128 evaluates the new recommendations and requirements in IEEE 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 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 484-1975 but deleted in IEEE 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 484.

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C. REGULATORY POSITION

Conformance with the IEEE 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:

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1. In Subsection 2.0, "References," the recommended practice shall be used in conjunction with two other battery-related IEEE publications, and 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 308, 'Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,' as endorsed by Regulatory Guide 1.32
- IEEE 336-2005, 'Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control at Nuclear Facilities'
- IEEE 344, 'Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,' as endorsed by Regulatory Guide 1.100
- IEEE 450, 'Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications,' as endorsed by Regulatory Guide 1.129
- IEEE 384, 'Standard Criteria for Independence of Class 1E Equipment and Circuits,' as endorsed by Regulatory Guide 1.75"

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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 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.'"

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

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

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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 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.'"

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COMMENT: There is no technical basis for this change. The pre-charge readings if taken before the post installation discharge test are only used for the freshening charge and have no value as records of battery condition. If the freshening charge occurs after the post installation discharge test, then the requirements of IEEE 450 supersede this requirement.

6. Subsection 6.3.4, "Acceptance test," should be revised to specify that the test is required upon initial installation, as follows:

"Upon initial installation, a test Service Test or Modified Performance Test shall be conducted in accordance with IEEE 450, as endorsed by Regulatory Guide 1.129." If a factory acceptance test was not performed, then a Modified Performance Test or a combination of a Performance Test and Service is required. **COMMENT: The purpose of this requirement is to demonstrate the ability of the battery to meet the TS requirements of the load profile and capacity. IEEE 450 defines an acceptance test as a capacity test which does not meet the intent to demonstrate the high rate capability in the as installed condition. IEEE 450 allows us to take credit for the factory acceptance for up to 2 years following installation. However, if the factory test is omitted, then in order to demonstrate that battery meets the capacity requirements an installation capacity test is required.**

Deleted: In Subsection 6.3.1, "Freshening Charge Sequence," item (a), the first sentence should be revised to delete sampling of specific gravity readings and be replaced with the following:

"(a) Prior to applying the charge, measure and record the open circuit voltage, electrolyte temperature, and specific gravity of every cell."

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COMMENT: This is a 10CFR50 Appendix b requirement and does not need to be included in this Reg. Guide.

7. In addition to the requirements of IEEE 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 requirements:

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

(b) Subsection 5.1, "Location," item (d) recommends that the battery should 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 discharge. In addition, the examples of induced phenomena should be revised to add the following:

"environmental hazards."

COMMENT: "Environmental Hazards" is an ambiguous term. The author needs to clarify what types of environmental hazards are to be protected against or delete this change.

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

"Where portable or stationary water facilities are provided within the battery room, their

Deleted: 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."

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design should preclude any inadvertent spilling of water from these facilities onto the battery itself." **COMMENT: The deleted text is redundant with the existing wording and is not required.**

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(d) In Subsection 5.5, "Instrumentation and Alarms," the four listed recommendations should be supplemented with the following two additions:

"(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 6.2.2 k specifically includes the endorsement of Informative Annex A for measuring intercell connection resistances.

(g) Subsection 6.3.2, "Data collection," should be supplemented with the following:

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"(h) 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')."

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(i) Subsection 7, "Records," should be supplemented with the following:

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"(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 draft regulatory guide. No backfitting is intended or approved in connection with its issuance.

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 installation design and installation of vented lead-acid storage batteries in nuclear power plants.

REGULATORY ANALYSIS

1. Statement of the Problem

Regulatory Guide 1.128, Revision 1, dated October 1978, currently endorses (with certain clarifying regulatory positions specified in Section C) IEEE 484-1975. IEEE 484-2002, which the IEEE-SA Standards Board approved on September 12, 2002, is an updated national consensus standard that reflects the current state of technology. The NRC's Office of Nuclear Reactor Regulation (NRR) has requested that the current regulatory guidance in Revision 1 of Regulatory Guide 1.128 be updated based on the latest available information to support the licensing of new reactors. IEEE 484-2002 is generalized for stationary batteries for generating stations and substations, and has been relaxed to delete the IEEE 484-1975 recommendations and requirements specific to nuclear power generating stations. Further some of the recommendations and requirements in IEEE 484-2002 conflict with NRC regulations and guidance. In addition, use of IEEE 484-2002 must consider recommendations and requirements specific to nuclear power generating stations.

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2. Technical Approach

In developing Draft Regulatory Guide DG-1154, the NRC staff considered the following alternative approaches:

(1) Take no action. IEEE 484 has been updated to reflect the current state of technology, and is being used by applicants for new 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 and uses outdated references to other regulatory guides. Moreover, without revised regulatory guidance, NRR will most likely require additional resources to evaluate the differences where the more recent revision is used in applications for new reactors. As a result, the staff did not select this approach.

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(2) Revise Regulatory Guide 1.128 to incorporate previous regulatory positions pertaining to this subject matter, and endorse IEEE 484-2002. Revision 2 of Regulatory Guide is intended for new plants. The battery installation design and installation have been completed for current operating reactors, so it is unlikely that the this revision would be completely adopted for batteries currently in service. However, current operating reactors could voluntarily use IEEE 484-2002 for future new battery installations.

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The general approach was to compare IEEE 484-2002 to IEEE 484-1975 to identify the changes to be evaluated with regard to their impact on the regulatory positions in Revision 1 of Regulatory Guide 1.128. The general approach also maintained the current regulatory position, so current plants could adopt IEEE 484-2002 in whole or in part without any cost impact. Specifically, regulatory positions were developed to supplement the information in IEEE 484-2002 with (1) information specific to nuclear power generating stations, which was contained in IEEE 484-1975 but was deleted in IEEE 484-2002, and (2) regulatory guides that directly apply to the topics addressed.

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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 484-1975, as endorsed by Revision 1 of this guide, has been in use for many years and is familiar to the industry. However, IEEE 484-1975 is not being used by applicants for new reactors.

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Value: Industry familiarity with Revision 1 of Regulatory Guide 1.128.

Impact: Schedule and staff costs to the NRC and applicants associated with evaluating case-by-case differences between IEEE 484-1975 (as endorsed by Revision 1 of Regulatory Guide 1.128) and (when used) IEEE 484-2002.

3.2 Alternative 2: Revise Regulatory Guide 1.128 To Incorporate Previous Regulatory Positions Pertaining to this Subject Matter, and Endorse IEEE Std 484-2002

Value: IEEE 484-2002 reflects the current state of technology and incorporates some of the regulatory positions of Revision 1 of Regulatory Guide 1.128, which, if adopted for new reactors or current operating reactors, will help to ensure compliance of battery installation design and installation to General Design Criteria 1, 17, and 18 (as set forth in Appendix A to 10 CFR Part 50), and Criterion III (as set forth in Appendix B to 10 CFR Part 50).

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Impact: The general approach maintained the current regulatory positions, so there would be no impact on current operating reactors.

4. Conclusion

The staff recommends that the NRC issue Revision 2 of Regulatory Guide 1.128 to endorse IEEE 484-2002 for battery installation design and installation. 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.

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BACKFIT ANALYSIS

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

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