U.S. NUCLEAR REGULATORY COMMISSION

DRAFT REGULATORY GUIDE DG-1412

Proposed Revision 1 to Regulatory Guide 1.210

Issue Date: January 2023
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QUALIFICATION OF CLASS 1E BATTERY CHARGERS, INVERTERS, AND UNINTERRUPTIBLE POWER SUPPLY SYSTEMS FOR PRODUCTION AND UTILIZATION FACILITIES

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes an approach that is acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) to meet regulatory requirements for the qualification of safety-related or Class 1E battery chargers, inverters, and uninterruptible power supply systems for production and utilization facilities. It endorses Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 650-2017, "IEEE Standard for Qualification of Class 1E Static Battery Chargers, Inverters, and Uninterruptible Power Supply Systems for Nuclear Power Generating Stations" (Ref. 1).

Applicability

This RG applies to reactor licensees subject to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 2), or 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 3). Under 10 CFR Part 50, this RG applies to licensees or applicants for nuclear power plants and utilization facilities. Under 10 CFR Part 52, this RG applies to applicants and holders of combined licenses, standard design certifications, standard design approvals, and manufacturing licenses.

Applicable Regulations

- 10 CFR Part 50 requires that structures, systems, and components (SSCs) that are important to safety must be designed to accommodate the effects of environmental conditions (i.e., remain functional under postulated design basis events).
    - 10 CFR 50.49(b)(1) and (c)(3) define safety-related equipment and a mild environment, respectively.

- 10 CFR 50.55a(h)(3) requires safety systems to meet the requirements for safety systems in IEEE Std. 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations" (Ref. 4) and the correction sheet dated January 30, 1995, if applications for construction permits and operating licenses under 10 CFR Part 50, and for design approvals, design certifications, and combined licenses under 10 CFR Part 52, were filed on or after May 13, 1999. The system criteria identified in this standard, include the qualification for the safety system equipment to demonstrate that the equipment can perform its safety functions as specified in the design basis.

- 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants":

  - General Design Criterion (GDC) 1, "Quality standards and records," requires 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 2, "Design bases for protection against natural phenomena," requires that SSCs important to safety be "designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions."

  - GDC 4, "Environmental and dynamic effects design bases," requires that SSCs important to safety 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."

- 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion III, "Design Control," Criterion XI, "Test Control," and Criterion XVII, "Quality Assurance Records," require design control measures to verify the adequacy of the design, a test program to assure that all testing required to demonstrate that SSCs will perform satisfactorily in service is performed in accordance with written procedures, and the maintenance of sufficient records as evidence of quality assurance activities, respectively. Criterion III specifically requires that a test program used to verify the adequacy of a specific design feature shall include suitable qualification testing of a prototype unit under the most adverse design conditions.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," requires that SSCs important to safety be designed to "withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety functions."

- 10 CFR Part 52 governs the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses. Part 52 specifies, among other things, that contents of some applications must satisfy the requirements of 10 CFR Part 50, Appendix A, Appendix B, Appendix S, and 50.55a.

Related Guidance

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (Ref. 5), provides guidance to the NRC staff in performing safety

reviews under 10 CFR Part 50 and 10 CFR Part 52. Specifically, Section 8.3.1, "A-C Power Systems (Onsite)," Section 8.3.2, "D-C Power Systems (Onsite)," and Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," contain review guidance related to the environmental qualification of safety-related electrical equipment. Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," contains review guidance for the seismic qualification of electrical equipment in the event of a seismic occurrence.

- RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants" (Ref. 6), discusses, in part, the seismic qualification of electrical equipment.

- RG 1.152, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants" (Ref. 7), gives guidance for designing digital systems, including computer hardware, software, firmware, and interfaces in the safety systems.

- RG 1.156, "Qualification of Connection Assemblies for Nuclear Power Plants" (Ref. 8), describes a method that the NRC staff considers acceptable for complying with the Commission's regulations on the environmental qualification of connection assemblies and environmental seals in combination with cables or wires as assemblies for service. The environmental qualification helps ensure that connection assemblies can perform their safety functions during and after a design-basis event.

- RG 1.158, "Qualification of Safety-Related Vented Lead-Acid Storage Batteries for Nuclear Power Plants" (Ref. 9), describes methods and procedures the NRC staff considers acceptable for use in complying with NRC regulations on the qualification method of safety-related lead-acid storage batteries.

- RG 1.164, "Dedication of Commercial-Grade Items for Use in Nuclear Power Plants" (Ref. 10), gives guidance on the dedication of commercial-grade items and services.

- RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems" (Ref. 11), describes design, installation, and testing practices acceptable to the NRC staff for addressing the effects of electromagnetic interference/radiofrequency interference and power surges on safety-related instrumentation and control systems.

- RG 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants" (Ref. 12), describes an acceptable method for demonstrating environmental qualification for digital instrumentation and control systems and addresses service conditions that include electromagnetic and power surge environments.

- RG 1.211, "Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants" (Ref. 13), describes a method that the NRC staff considers acceptable for complying with the Commission's regulations for the qualification of safety-related cables and field splices.

- NUREG-1537, Parts 1 and 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," issued February 1996 (Ref. 14), 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, Parts 1 and 2 "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," issued October 2012 (Ref. 15), gives 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 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. 16) which endorses with clarifications, Appendix A, "Part 1, Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power MSRs: Format and Content," of the report titled, "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. 17).

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 describe information that the staff needs in its review of applications for permits and licenses. Regulatory guides 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 Parts 50 and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), 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 Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011 and 3150-0151), Office of Management and Budget, Washington, DC, 20503.

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

This revision (Revision 1) of RG 1.210 revises the title of the RG to clarify that other nuclear facilities are also within the scope of this RG and updates the RG to endorse the 2017 version of IEEE Std. 650, which addresses new issues identified since the RG's original issuance. These new issues include qualification of uninterruptible power supply (UPS) systems and programmable digital devices included in direct current (dc) power sources and qualification of the equipment to withstand electrical transients during operation. Notably, the revised standard also clarifies mechanical cycling steps for connectors and functional monitoring recommended during environmental stress test and acceptable methods for seismic testing that were discussed in the regulatory positions of Revision 0 of the RG. The information in this revised guide is specific to the qualification of safety-related equipment important to safety located in mild environments at production and utilization facilities licensed under 10 CFR Part 50 or 10 CFR Part 52.

Background

RG 1.210, "Qualification of Safety-Related Battery Chargers and Inverters for Nuclear Power Plants," Revision 0, issued June 2008 (Ref. 18), endorsed IEEE Std. 650-2006, "IEEE Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations," (Ref. 19) which provided methods for qualifying battery chargers and inverters in accordance with IEEE Std. 323-2003, "IEEE Standard for Qualifying Class 1E Electrical Equipment for Nuclear Power Generating Stations" (Ref. 20). In 2016, the IEEE issued Std. 323 jointly with the International Electrotechnical Commission (IEC) as IEC/IEEE Std. 60780-323-2016, "IEC/IEEE International Standard—Nuclear Facilities—Electrical Equipment Important to Safety—Qualification" (Ref. 21). The joint standard describes principles, methods, and procedures for qualifying, maintaining, and extending qualification, as well as updating qualification, of Class 1E equipment and interfaces, including components or equipment of any interface whose failure could adversely affect any Class 1E equipment.

IEEE Std. 650-2017 provided updates to the 2006 version including the qualification of safety-related UPS systems. UPS systems are designed to provide a continuous, highly reliable source of alternating current (ac) supply automatically, without delay or transients, during any period when the normal power supply is incapable of performing acceptably. UPS systems may include inverters, battery chargers, rectifiers (ac-dc converters), static transfer switches, maintenance bypass switches, and line regulating transformers. Power supplies for low voltage critical loads such as reactor protection systems may include a standalone UPS or a UPS formed by an inverter connected to a dc source working in conjunction with an alternate ac source and a fast-acting automatic transfer switch. Components used in inverters are included in UPS systems.

IEEE Std. 650-2017 also clarified the use of the standard for qualification of safety-related battery chargers, inverters, and UPS systems located in a mild environment. The definition of "mild environment", as provided in 10 CFR 50.49(c)(3), is, "an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences," which include loss of all offsite power.[1] Specifically, 10 CFR 50 Appendix A, GDC 2, and Appendix S require that safety-related equipment including equipment in a mild environment be capable of withstanding the effects of natural phenomena such as earthquakes (seismic events). Additionally, in accordance with 10 CFR 50.55a(h)(3) and 10 CFR 50 Appendix A, GDC 4,

1 The reference to 10 CFR 50.49(c)(3) is being provided for definitional purposes. The environmental qualification of electrical equipment important to safety located in a mild environment is not within the scope of 10 CFR 50.49.

safety-related equipment, including equipment in a mild environment, is required to be qualified to perform its functions when subjected to environmental and natural phenomena associated with normal and abnormal conditions. Based on the above-mentioned requirements, safety-related battery chargers, inverters, and UPS systems in production and utilization facilities must be qualified to perform their functions in normal and abnormal environmental conditions, and design-basis seismic events, as these are typically located in a mild environment.

IEEE Std. 650-2017 updated the qualification for the safety-related battery chargers, inverters, and UPS systems in accordance with the joint standard IEC/IEEE Std. 60780-323. Equipment qualification, as defined in IEEE Std. 650-2017, is the "generation and maintenance of evidence to ensure that equipment will operate on demand to meet system performance requirements during normal and abnormal service conditions and postulated design basis events." IEEE Std. 650-2017 described an equipment qualification process that involves a combination of analysis and type testing methods and recommended that the analysis methods include a justification of the methods, theories, and assumptions used.

IEEE Std. 650-2017 further incorporated a software analysis and a transient test into the qualification methods. Safety-related static battery chargers, inverters, and UPS systems may contain programmable digital devices. Section 5.1.2.1, "Software Analysis," of IEEE Std. 650-2017 provides guidance for the qualification of these programmable digital devices to demonstrate that they can perform their safety functions. In addition, safety-related static battery chargers, inverters, and UPS systems in production and utilization facilities are designed to remain operable during anticipated transient events, such as a large electrical load rejection, a main turbine generator trip, a loss of offsite power with subsequent emergency diesel generator start and load, and a loss of ac power to UPS systems. Also, operating experience has indicated that asymmetric electrical transients are also possible. IEEE Std. 650-2017, Section 5.1.3.5, "Transient Test," provides transient testing that will ensure the equipment is capable of functioning during transient events, if required.

IEEE Std. 650-2017 incorporated regulatory positions in RG 1.210, Revision 0, regarding the criterion for ignoring mechanical cycling of connectors as an aging factor during the acceleration aging process and the functional performance monitoring during the environmental stress test, in Section 5.2.2.4, "Wire, cable, terminal blocks, and connections," and Section 5.3.1.7, "Environmental Stress Test," respectively. Furthermore, the regulatory position in RG 1.210, Revision 0, related to the qualification methods for seismic testing was clarified in Section 5.3.1.8, "Seismic Test," of IEEE Std. 650-2017.

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. 22) and Management Directive and Handbook 6.6, "Regulatory Guides" (Ref. 23). The NRC staff did not identify any IAEA Safety Requirements or Guides with information related to the topic of this RG.

This RG is endorsing IEEE Std. 650-2017, which provides qualification methods based on the joint IEC/IEEE Std. 60780-323, Edition 1.0, 2016-02. This joint standard was created based on a collaborative international effort to harmonize standard qualification practices developed from

IEC 60780:1998, “Nuclear Power Plants—Electrical Equipment of the Safety System—Qualification” (Ref. 24), and IEEE Std. 323-2003.

Documents Discussed in Staff Regulatory Guidance

This RG endorses 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 NRC staff considers conformance with the requirements of IEEE Std. 650-2017 to be a method that is acceptable for use in satisfying the regulations with respect to the qualification of safety-related or Class 1E battery chargers, inverters, and UPS systems.

D. IMPLEMENTATION

The NRC staff may use this regulatory guide 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 regulatory guide 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. 25), 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 [2]

The References section applies to versions of the documents available at the time of this RG's issuance. Licensees or applicants using this RG should check all referenced documents to ensure no change has occurred since issuance of the RG.

1. Institute of Electrical and Electronics Engineers (IEEE), IEEE Standard 650-2017, "IEEE Standard for Qualification of Class 1E Static Battery Chargers, Inverters, and Uninterruptible Power Supply Systems for Nuclear Power Generating Stations," New York, NY.[3]

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. IEEE Standard 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations," New York, NY.

5. U.S. Nuclear Regulatory Commission (NRC), NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," Washington, DC.

6. NRC, Regulatory Guide (RG) 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Washington, DC.

7. NRC, RG 1.152, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants," Washington, DC.

8. NRC, RG 1.156, "Qualification of Connection Assemblies for Nuclear Power Plants," Washington, DC.

9. NRC, RG 1.158, "Qualification of Safety-Related Vented Lead-Acid Storage Batteries for Nuclear Power Plants," Washington, DC.

10. NRC, RG 1.164, "Dedication of Commercial-Grade Items for Use in Nuclear Power Plants," Washington, DC.

11. NRC, RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," Washington, DC.

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2 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 online 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.

3 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.

12. NRC, RG 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants," Washington, DC.

13. NRC, RG 1.211, "Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants," Washington, DC.

14. NUREG-1537, Parts 1 and 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," issued February 1996. (ADAMS Accession Numbers Accession Numbers ML12156A069 and ML12156A075, respectively)

15. NRC, "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," Washington, DC, October 17, 2012. (ML12156A053)

16. "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. (ML20251A008)

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

18. NRC, RG 1.210, "Qualification of Safety-Related Battery Chargers and Inverters for Nuclear Power Plants," Revision 0, Washington, DC.

19. IEEE Standard 650-2006, "IEEE Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations," New York, NY.

20. IEEE Standard 323-2003 "IEEE Standard for Qualifying Class 1E Electrical Equipment for Nuclear Power Generating Stations," New York, NY.

21. International Electrotechnical Commission (IEC)/IEEE Std. 60780-323, "IEC/IEEE International Standard—Nuclear Facilities—Electrical Equipment Important to Safety—Qualification," Edition 1.0, New York, NY.[4]

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

23. NRC, Management Directive (MD) 6.6, "Regulatory Guides," Washington, DC.

24. IEC 60780:1998, "Nuclear Power Plants—Electrical Equipment of the Safety System—Qualification," Geneva, Switzerland, October 1998.[5]

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

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4 Copies may be obtained from the Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY 10016-5997.

5 Copies of International Electrical Commission (IEC) documents may be obtained through the IEC Web site, http://www.iec.ch/, or by writing the IEC Central Office at P.O. Box 131, 3 Rue de Varembé, 1211 Geneva, Switzerland, telephone +41 22 919 02 11.