



IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits

IEEE Power & Energy Society

Sponsored by the
Nuclear Power Engineering Committee

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IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits

Sponsor

**Nuclear Power Engineering Committee
of the
IEEE Power & Energy Society**

Approved 26 September 2008

IEEE-SA Standards Board

Abstract: The independence requirements of the circuits and equipment comprising or associated with Class 1E systems are described. Criteria for the independence that can be achieved by physical separation and electrical isolation of circuits and equipment that are redundant are set forth. The determination of what is to be considered redundant is not addressed.

Keywords: associated circuit, barrier, Class 1E, independence, isolation, isolation device, raceway, separation

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Introduction

This introduction is not part of IEEE Std 384-2008, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.

This standard provides criteria and requirements for establishing and maintaining the independence of Class 1E equipment and circuits and auxiliary supporting features by physical separation and electrical isolation. The 1992 revision of IEEE Std 384 incorporated separation criteria changes based on the results of separation testing completed by the nuclear industry on internally generated electrical faults. Where sufficient testing data were available, the separation distances were reduced. New configurations were also added including cable trays and conduits, cable trays and cable in free air, and conduits and cable in free air. See Annex B for additional discussion of the test programs.

The IEEE has developed these criteria to provide guidance in the determination of the independence requirements related to the Class 1E systems of the nuclear facility. Adherence to these criteria may not fully address public health and safety issues because it is the integrated performance of the structures, the fluid systems, and the instrumentation and electrical systems of the station that determine the consequences of accidents. Failure to meet these requirements may be an indication of system inadequacy. Each applicant has the responsibility to provide assurance that this integrated performance is adequate.

The principal changes in this revision include the following:

Working Group for Independence Criteria and Design of Control Boards, Panels, and Racks (WG 6.5) investigated the application of physical separation criteria to fiber-optic cable used in Class 1E and non-Class 1E circuits. No analyses or testing programs specific to the physical separation of fiber-optic cables have been performed to date by the nuclear industry as far as WG 6.5 knows. In lieu of this, WG 6.5 recognized that fiber-optic cable rated for the same temperature as current carrying instrumentation cable would produce similar results in a testing program. WG 6.5 used the same testing programs that formed the basis for the 1992 revision and extrapolated the results, with margin, to produce separation criteria for fiber-optic cable. WG 6.5 also recognized that fiber-optic cable is not capable of generating a fire due to an internally generated fault and does not require separation from other fiber-optic cable, or from current carrying cable, when fiber-optic cable is considered the source of the potential fire. The isolation device requirements for control and instrumentation circuits in 6.2 were also enhanced to reflect the inherent electrical isolation characteristics of fiber-optic circuits. See Annex C for additional discussion of fiber-optic circuits.

WG 6.5 reviewed the effects of electromagnetic interference/radio frequency interference (EMI/RFI) to determine appropriate guidance for maintaining independence of Class 1E circuits. EMI/RFI was recognized as an effect that could be addressed through qualification of equipment, physical arrangement of equipment and systems in the plant, or maintenance and testing. A panel session was sponsored on January 26, 2005, by the Nuclear Power Engineering Committee (NPEC), including representatives from the Electric Power Research Institute (EPRI), equipment manufacturers, the Nuclear Regulatory Commission (NRC), and an independent consultant in the field. Results of the panel session were reviewed by a committee of representatives from the Subcommittee on Qualifications (SC2), the Subcommittee on Operations, Maintenance, Aging, and Testing (SC3), and the Subcommittee on Safety Related Systems (SC6). The committee's final recommendation, as approved by NPEC on August 3, 2005, was that no new standard was warranted to address EMI/RFI. Instead, additional guidance for mitigating EMI/RFI should be included in Annex B of IEEE Std 603^{TM a} and referenced by other standards. WG 6.5 has provided general guidance in this revision of IEEE Std 384 to address the effects of EMI/RFI and to provide a reference to Annex B of IEEE Std 603 for further specific guidance.

^a Information on references can be found in Clause 2.

This revision also changed the format of the distance criteria to be metric (followed by English units in parentheses) to match the usage criteria given in IEEE/ASTM SI 10™-2002 [B2].^b WG 6.5 recognized that the specific English separation distances needed to be maintained because some were based on actual cable and raceway test, and that many of the criteria appear in nuclear power plants' design and licensing bases. Some of the metric distances were changed to better match the conversion formulas given in IEEE/ASTM SI 10, to minimize rounding error, to keep the metric value greater than or equal to the English or within a very small error less than the English to ensure conservative separation distance, and to limit the number of significant digits.

Other clauses of this standard have been reviewed, and many editorial improvements have been made, including updating the standard to the latest *IEEE Standards Style Manual*.

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^b The numbers in brackets correspond to those of the bibliography in Annex A.

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Participants

At the time this standard was submitted to the IEEE-SA Standards Board for approval, WG 6.5 had the following membership:

Randy C. Jamison, *Chair*

Ijaz Ahmad
John J. Disosway

Patrick Gove

Mark Walsh
Paul L Yanosy Sr.

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

William J. Ackerman
Stan Arnot
Farouk Baxter
Wesley Bowers
Daniel Brosnan
Nissen Burstein
Robert Carruth
Suresh Channarasappa
John Coyle
Dennis Dellinger
John J. Disosway
Gary Engmann
Stephen A. Fleger
Robert Fletcher

James Gleason
Randall Groves
Daryl Harmon
Evans Heacock
Hamidreza Heidarisafa
David Horvath
Randy C. Jamison
James Jones
Joseph L. Koepfinger
G. Lang
Harvey Leake
John Macdonald
Omar Mazzoni
Kimberly Mosley
Michael S. Newman

Gerald L. Nicely
James Parelo
Ted Riccio
Charles Rogers
Fredrick Roy
Glen Schinzel
David Smith
Brandon Swartley
S. Thamilarasan
James Thompson
John Vergis
James Wilson
Paul L Yanosy Sr.
David Zaprazny

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Thomas Prevost, *Vice Chair*
Steve M. Mills, *Past Chair*
Judith Gorman, *Secretary*

Victor Berman
Richard DeBlasio
Andy Drozd
Mark Epstein
Alexander Gelman
William R. Goldbach
Arnold M. Greenspan
Kenneth S. Hanus

Jim Hughes
Richard H. Hulett
Young Kyun Kim
Joseph L. Koepfinger*
John Kulick
David J. Law
Glenn Parsons

Ronald C. Petersen
Chuck Powers
Narayanan Ramachandran
Jon Walter Rosdahl
Anne-Marie Sahazizian
Malcolm V. Thaden
Howard L. Wolfman
Don Wright

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Satish K. Aggarwal, *NRC Representative*
Michael H. Kelley, *NIST Representative*

Jennie Steinhagen
IEEE Standards Program Manager, Document Development

Matthew J. Ceglia
IEEE Standards Program Manager, Technical Program Development

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1. Overview

1.1 Scope

This standard describes the independence requirements of the circuits and equipment comprising or associated with Class 1E systems. It sets forth criteria for the independence that can be achieved by physical separation and electrical isolation of circuits and equipment that are redundant, but does not address the determination of what is to be considered redundant.

1.2 Purpose

This standard establishes the criteria for implementation of the independence requirements of IEEE Std 308TM¹ and IEEE Std 603TM.

¹ [Information on references can be found in Clause 2.](#)

2. Normative references

The following ~~publications shall be used in conjunction with this standard. When they are superseded by an approved revision, the revision shall apply:~~ [referenced documents are indispensable for the application of this document \(i.e., they must be understood and used, so each referenced document is cited in the text and its relationship to this document is explained\). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document \(including any amendments or corrigenda\) applies.](#)

ANSI/ANS 58.2-~~1988~~, Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture.²

[ANSI/NFPA 30, Flammable and Combustible Liquids Code.](#)³

ANSI/NFPA 80A-~~1987~~, [Recommended Practice for](#) Protection of Buildings from Exterior Fire Exposures.

ANSI/NFPA 803-~~1988~~, Fire Protection for Light Water Nuclear Power Plants.

ASTM E84-~~91a~~, [Standard](#) Test Method for Surface Burning Characteristics of Building Materials.⁴

[†]The numbers in brackets correspond to the references listed in Section 3. of this standard

[ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials.](#)

[ASTM E136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 °C.](#)

~~[6] ASTM E119-88, Method for Fire Tests of Building Construction and Materials.~~

~~[7] ASTM E136-92, Test for Behavior of Materials in a Vertical Tube Furnace at 750 °C.~~

~~[11] IEEE Std 494-1974 (Reaff 1990), IEEE Standard Method for Identification of Documents Related to Class 1E Equipment and Systems for Nuclear Power Generating Stations (ANSI).~~

~~[13] IEEE Std 628-1987, IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations (ANSI).~~

IEEE Std 308TM-~~1991~~, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.^{5, 6}

IEEE Std 338TM-~~1974~~, IEEE Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems.

[IEEE Std 383TM, IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations.](#)

IEEE Std 420TM, IEEE Standard for the Design and Qualification of Class 1E Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations.

IEEE Std 603TM-~~1991~~, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.

[IEEE Std 628TM, IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations.](#)

IEEE Std 690TM-~~1984~~, IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations.

NEMA VE 1-~~1991~~, Metal Cable Tray Systems.⁷

² ANSI publications are available from the American ~~Nuclear Society, 555 N. Kensington, La Grange Park, IL 60525.~~ [National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA \(http://www.ansi.org/\).](#)

³ NFPA publications are published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, USA (<http://www.nfpa.org/>).

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⁵ IEEE publications are available from the [Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331,](#)