

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

Sponsor
**Nuclear Power Engineering Committee
of the
IEEE Power Engineering Society**

Reaffirmed February 5, 1999
Approved December 31, 1992

American National Standards Institute

Reaffirmed March 19, 1998
Approved June 18, 1992

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, race-way, separation.

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345 East 47th, New York, NY 10017-2394, USA

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ISBN 1-55937-236-2

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Foreword

(This foreword is not a part of IEEE Std 384-1992, 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.

This 1992 revision of IEEE Std 384-1981, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits, reflects the results of separation testing completed by the nuclear industry on internally generated electrical faults. The working group has performed the following activities:

- 1) Assessed completed industry test reports to determine their applicability in support of changes in separation distances and reported these results to the Nuclear Power Engineering Committee (NPEC).
- 2) Conducted a panel discussion on the test results at the 1988 Institute of Electrical and Electronics Engineers (IEEE) Winter Power Meeting.
- 3) Presented a technical paper on the test results at the 1989 IEEE Winter Power Meeting (IEEE Paper No. 90 WM 254-3EC).

The working group's review has resulted in changes to Section 6. of the standard as follows:

- 1) Separation distance criteria for configurations identified in IEEE Std 384-1981 have been reduced in some cases. In other cases, insufficient testing data were available to support reducing the distances in IEEE Std 384-1981.
- 2) Separation distance criteria for configurations not addressed in IEEE Std 384-1981 have been added to the standard based on test results. These configurations include cable trays and conduits, cable trays and cable in free air, and conduits and cable in free air.

Other sections of this standard have been reviewed, and many editorial improvements have been made. As part of this work, the working group assessed Nuclear Regulatory Commission (NRC) Regulatory Guide 1.75, Revision 2, which endorses IEEE Std 384-1974.

A Request for Interpretation of IEEE 384-1977, Paragraph 6.1.2 (now 7.1.2), was received by the working group regarding the phrase "maximum credible voltage or current transient." A definition of this phrase has been added to the standard.

A request for proposed revision from the DC Auxiliary Power Working Group (Nuclear Power Subcommittee of the Power Generation Committee) was received regarding the use of fuses as isolation devices in power circuits. The standard has been revised to permit the use of fuses as isolation devices in power circuits.

Section 8 of IEEE Std 384-1981 was previously included to provide *interim* criteria for implementation of independence requirements for safe shutdown systems required for exposure fires. 10 CFR 50, Appendix R has since been issued to provide the requirements for safe shutdown; consequently, Section 8 has been eliminated from the present issue of this standard.

The Working Group has received suggestions and recommendations regarding the application of fiber optic cabling to Class 1E circuits. However, to date, there have been no analyses or test programs submitted to the Working Group to support special criteria for separating these cables in a manner different than already provided by considering them equivalent to typical instrumentation cable. If sufficient information becomes available to justify special separation criteria, the Working Group will consider adding this criteria to the standard in a future revision.

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 suffice for assuring the public health and safety, because it is the integrated performance of the structures, the fluid systems, and the instrumentation and electric systems of the station that establish the consequences of accidents. Failure to meet these requirements may be an indication of system inadequacy. Each applicant has the responsibility to assure himself and others that this integrated performance is adequate.

The Working Group feels that the criteria herein represent an industry and government consensus for ascertaining the adequacy of the independence of Class 1E systems.

The revision to this standard was prepared by Working Group SC 6.5 of Subcommittee 6 under the NPEC. At the time this standard was approved, the members of Working Group SC 6.5 were as follows:

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The Working Group acknowledges the contribution of T. S. Killen, former Working Group Chair, to the preparation of this revision.

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

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.

2. Purpose

This standard establishes the criteria for implementation of the independence requirements of IEEE Std 603-1991 [12]¹ and IEEE Std 308-1991 [8].

3. References

The following publications shall be used in conjunction with this standard. When they are superseded by an approved revision, the revision shall apply:

- [1] ANSI/ANS-58.2-1988, Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture.²
- [2] ANSI/NFPA 80A-1987, Protection of Buildings From Exterior Fire Exposures.³
- [3] ANSI/NFPA 321-1987, Basic Classification of Flammable and Combustible Liquids.
- [4] ANSI/NFPA 803-1988, Fire Protection for Light Water Nuclear Power Plants.
- [5] ASTM E84-91a, Test Methods for Surface Burning Characteristics of Building Materials.⁴

¹ The numbers in brackets correspond to the references listed in Section 3. of this standard.

² ANS publications are available from the American Nuclear Society, 555 N. Kensington, La Grange Park, IL 60525.

³ NFPA publications are available from Publication Sales, National Fire Protection Association, 1 Batterymarch Park, P. O. Box 9101, Quincy, MA 02269-9101, USA.

⁴ ASTM publications are available from the Customer Service Department, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, USA.

- [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.
- [8] IEEE Std 308-1991, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations (ANSI).
- [9] IEEE Std 383-1974 (Reaff 1992), IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations (ANSI).⁵
- [10] IEEE Std 420-1982, IEEE Standard for the Design and Qualification of Class 1E Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations (ANSI).
- [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).
- [12] IEEE Std 603-1991, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.
- [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).
- [14] IEEE Std 690-1984, IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations.
- [15] NEMA VE 1-1991, Metallic Cable Tray Systems.⁶

4. Definitions

acceptable: Demonstrated to be adequate by the safety analysis of the station.

associated circuits: Non-Class 1E circuits that are not physically separated or are not electrically isolated from Class 1E circuits by acceptable separation distance, safety class structures, barriers, or isolation devices.

NOTE — Circuits include the interconnecting cabling and the connected loads.

auxiliary supporting features: Systems or components that provide services (such as cooling, lubrication, and energy supply) that are required for the safety system to accomplish its safety functions.

barrier: A device or structure interposed between redundant Class 1E equipment or circuits, or between Class 1E equipment or circuits and a potential source of damage to limit damage to Class 1E systems to an acceptable level.

cable in free air: That portion of a cable not routed in either a raceway or an enclosure.

Class 1E: The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing a significant release of radioactive material to the environment.

design basis events: Postulated abnormal events used in the design to establish the acceptable performance requirements of the structures, systems, and components.

division: The designation applied to a given system or set of components that enables the establishment and maintenance of physical, electrical, and functional independence from other redundant sets of components.

⁵ IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

⁶ NEMA publications are available from the National Electrical Manufacturers Association, 2101 L Street, NW, Washington, DC 20037, USA.

NOTE — The terms division, train, channel, separation group, safety group, or load group, when used in this context, are interchangeable.

enclosure: An identifiable housing, such as a cubicle, compartment, terminal box, panel, or enclosed raceway, used for electrical equipment or cables.

flame retardant: Capable of limiting the propagation of a fire beyond the area of influence of the energy source that initiated the fire.

independence: The state in which there is no mechanism by which any single design basis event, such as a flood, can cause redundant equipment to be inoperable.

isolation device: A device in a circuit that prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits.

maximum credible voltage or current transient: That voltage or current transient that may exist in circuits, as determined by test or analysis, taking into consideration the circuit location, routing, and interconnections combined with failures that the circuits may credibly experience.

raceway: Any channel that is designed and used expressly for supporting or enclosing wires, cable, or busbars. Raceways consist primarily of, but are not restricted to, cable trays and conduits.

redundant equipment or system: Equipment or system that duplicates the essential function of another piece of equipment or system to the extent that either may perform the required function regardless of the state of operation or failure of the other.

safety class structures: Structures designed to protect Class 1E equipment against the effects of the design basis events.

NOTE — For the purposes of this standard, separate safety class structures can be separate rooms in the same building. The rooms may share a common wall.

separation distance: Space that has no interposing structures, equipment, or materials that could aid in the propagation of fire or that could otherwise disable Class 1E systems or equipment.

5. General Independence Criteria

5.1 Required Independence

Physical separation and electrical isolation shall be provided to maintain the independence of Class 1E circuits and equipment so that the safety functions required during and following any design basis event can be accomplished.

5.2 Methods of Achieving Independence

The physical separation of circuits and equipment shall be achieved by the use of safety class structures, separation distance, or barriers or any combination thereof. Electrical isolation shall be achieved by the use of separation distance, isolation devices, shielding and wiring techniques, or combinations thereof.

5.3 Equipment and Circuits Requiring Independence

Equipment and circuits requiring independence shall be determined and delineated during the plant design and shall be identified on documents and drawings in a distinctive manner. (See IEEE Std 494-1974 [11] for guidance in identification.)