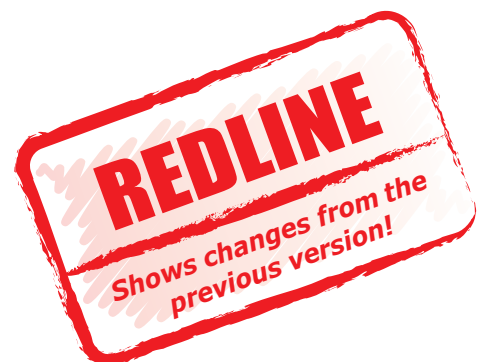


IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations

IEEE Power & Energy Society

Sponsored by the
Nuclear Power Engineering Committee



IEEE
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USA

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IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations

Sponsor

Nuclear Power Engineering Committee

of the

IEEE Power & Energy Society

Approved 7 December 2011

IEEE-SA Standards Board

Abstract: Criteria for the minimum requirements in the selection design, installation, and qualification of raceway systems for Class 1E circuits for nuclear power generating stations are provided in this standard. Methods for the structural qualification of raceway systems for Class 1E circuits are prescribed also.

Keywords: cable tray, conduit, design-by-rule, duct line, IEEE 628, raceways, seismic

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Introduction

This introduction is not part of IEEE Std 628-2011, IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations.

The original document was issued in 1987 and reaffirmed in 1992. During the process of reaffirmation, it was agreed to add earthquake experience data as an acceptable method of performing seismic qualification for raceway systems in the next revision of the standard. Therefore, the 2001 revision of this standard incorporated methods developed by the Seismic Qualification Users Group (SQUG). Annex B was added to the document to assist the user with the new methodology. The applicability of this methodology is contingent on its acceptability per the plant licensing basis. It should be noted, however, that the SQUG methodology was approved by the U.S. Nuclear Regulatory Commission (NRC) for verification of seismic adequacy of the cable tray systems at older nuclear power plants that were licensed prior to IEEE Std 344™-1975 [B5].^a Other changes made to the standard were format changes and upgrading of the document references. The definitions contained in the original and reaffirmed documents were removed as they are now contained in *The IEEE Standards Dictionary: Glossary of Terms & Definitions*.^b The working group also discussed the use of the term *Safety Class* in place of the term *Class 1E*. The working group felt that the definition and usage of these terms were established in IEEE Std 308™-1991 [B4], and this standard should conform to the established criteria. Therefore, use of the term *Class 1E* was maintained. In 2006, the standard was again reaffirmed.

This revision updates the references and addresses comments received during the reaffirmation process. In general, the readability of the standard was improved by clarifying wording, making editorial corrections, and improving the legibility of the figures in Annex D. In addition, minor changes were made to reflect input based on review of newer reactor design certification documents.

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1. Overview

1.1 Scope

This standard contains the requirements for the design, installation, and qualification of raceway systems for Class 1E circuits external to electric equipment and components for nuclear power generating stations. Because aging and radiation have no known detrimental effects upon metallic raceway systems and because nonmetallic raceway systems are limited to underground or embedded applications, aging and radiation are not considered in this standard. The embedments or structural members to which a support is attached are beyond the scope of this standard.

1.2 Purpose

The purpose of this standard is to provide criteria for the minimum requirements in the selection, design, installation, and qualification of raceway systems for Class 1E circuits for nuclear power generating stations. It also prescribes methods for the structural qualification of raceway systems for Class 1E circuits.

2. Normative references

The following 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 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.

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ACI 349-~~97~~/[349R-2006](#), Code Requirements for Nuclear Safety-Related Concrete Structures.¹

ANSI C80.1-~~1995~~ [2005](#), American National Standard ~~Specification~~ for [Electrical](#) Rigid Steel Conduit—~~Zinc Coated~~ (ERSC).²

ANSI C80.3-2005, American National Standard ~~Specification~~ for [Steel](#) Electrical Metallic Tubing—~~Zinc Coated~~ (EMT).

ANSI C80.5-~~1995~~ [2005](#), American National Standard for Electrical Rigid Aluminum Conduit ([ERAC](#)). ~~ARC~~

[ANSI C80.6-2005](#), [American National Standard for Electrical Intermediate Metal Conduit \(EIMC\)](#).

ASME ~~1995~~-Boiler and Pressure Vessel Code, Section IX: [Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators, 2010](#).³

ASME NQA 1-~~1997~~ [2008](#), Quality Assurance Program Requirements for Nuclear Facility Applications.

ASTM A123/[A123M-2009](#) ~~89~~, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.⁴

ASTM A653/A653M-[2009a](#), ~~99~~ Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM B633 -[2007](#) ~~98~~, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

ASTM B776-[2007](#) ~~86~~, Standard Specification for ~~Electro-Deposited Coatings of Cadmium~~, [Hafnium and Hafnium Alloy Strip, Sheet, and Plate](#). AWS D1.1-~~00~~ [/D1.1M-2010](#), Structural Welding Code—Steel, [22d ed.](#)⁵

AWS D1.3-~~98~~ [/D1.3M-2008](#), Structural Welding Code—Sheet Steel, [5th ed.](#)

IEEE Std 344-~~1987 (Reaff 1993)~~ [TM-2004](#), IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.^{6, 7}

IEEE Std 384-~~1992 (Reaff 1998)~~ [TM-2008](#), IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.

IEEE Std 665TM-1995 [\(Reaff 2001\)](#), IEEE Guide for Generating Station Grounding.

¹ ACI publications are available from the American Concrete Institute, P.O. Box 9094, Farmington Hills, MI 48333-[9094](#), USA (<http://www.concrete.org/>).

² ANSI publications are available from the Sales Department, American National Standards Institute, ~~11~~ [25](#) West ~~42nd~~ [43rd](#) Street, ~~13th~~ [4th](#) Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

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IEEE Std 690™ ~~-2004 1984 (Reaff 1996)~~, IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations.

NEMA FB 1- [2007](#) ~~1993~~ Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, [Electrical Metallic Tubing](#), and Cable.⁸ ~~Assemblies.~~

NEMA TC 2-[2003](#) ~~1998~~, Electrical Polyvinyl Chloride (PVC) ~~Tubing and~~ Conduit.

NEMA TC 3-[2004](#) ~~1999~~, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

NEMA TC 6 & 8 ~~-2003 1990~~, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations. ~~Extra-Strength PVC Plastic Utilities Duct for Underground Installation.~~

NEMA TC 9-[2004](#) ~~1999~~, Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.

NEMA VE 1-[2009](#) ~~1998~~, Metal Cable Tray Systems.

NFPA 70 ~~1999~~, National Electrical Code® (NEC®).⁹

UL 1-[2005](#) ~~2000~~, Safety Standard for Flexible Metal Conduit ([11th ed.](#)).¹⁰

UL 6-[2007](#) ~~2000~~, Safety Standard for Electrical Rigid Metal Conduit—Steel ([14th ed.](#)).

UL 514A-[2004](#) ~~1996~~, Safety Standard for Metallic Outlet Boxes ([10th ed.](#))

UL 514B-[2007](#) ~~1997~~, [Safety Standard for Conduit, Tubing, and Cable Fittings \(5th ed.\)](#). ~~Fittings for Conduit and Outlet Boxes.~~

UL 514C-~~1996~~, [2008](#), Safety Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers ([3rd ed.](#)).

UL 797-~~2000~~, [2007](#), Safety Standard for Electrical Metallic Tubing—Steel ([9th ed.](#)).

UL 1242-~~2000~~ [2006](#), Safety Standard for Intermediate Metal Conduit—Steel ([3d ed.](#)).

3. Acronyms and abbreviations

ABS acrylonitrile butadiene styrene

~~ACI American Concrete Institute~~

~~AISC American Institute of Steel Construction~~

~~ASI American Iron and Steel Institute~~

~~AWS American Welding Society~~

~~BWR boiling water reactor~~

DL dead load

EMT electrical metallic tubing

~~EPRI Electric Power Research Institute~~

~~HVAC heating, ventilation, and air conditioning~~

IMC intermediate metal conduit

LL live load

~~NFPA National Fire Protection Association~~

OBE operating basis earthquake

PE polyethylene

PVC polyvinyl chloride

RAC rigid aluminum conduit

RMC rigid metal conduit

RSC rigid steel conduit

RS response spectrum or spectra

⁸ NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

⁹ The NEC is published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, USA (<http://www.nfpa.org/>). Copies are also available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, ~~P.O. Box 1331~~ Piscataway, NJ 08854-4141, USA (<http://standards.ieee.org/>).

¹⁰ UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

SRSS square root of the sum of the squares

SRV safety relief valve

SSE safe shutdown earthquake

T thermal load

~~UL Underwriters Laboratories~~

ZPA_h horizontal zero period acceleration

4. Design

4.1 General

4.1.1 Material selection

In the design and installation of raceway systems, consideration shall be given to the relative structural integrity of aluminum versus steel when subjected to heat from postulated fires.

NOTE—Flexible conduit may not accommodate relative displacement in all installations. For additional guidelines pertaining to raceway systems, see Annex B.¹¹

4.1.2 Structural integrity

Raceway systems for Class 1E circuits are not Class 1E; however, they shall be designed to seismic Category 1 requirements to prevent failure during a seismic event. Documentation requirements for the race way system shall be in accordance with Clause 7 of this standard.

The raceway system shall be designed to perform its functions and shall not ~~damage~~ degrade the safety functions of adjacent safety-related systems ~~below an acceptable level~~ during and after experiencing all conditions postulated to occur in its environment. As a minimum, the design shall adhere to the basic requirements of this standard and of IEEE Std 384-~~1992~~⁺⁰ 2008.¹²

Clearances with respect to other systems shall be established and provided to ensure that movement due to loads and load combinations (~~see~~ 4.10.1) will not affect the integrity of the raceway system.

Relative displacement of the raceway system to other systems, equipment, or structures shall be considered in the design of raceway systems. The raceway supports shall be designed to accommodate differential settlement and deflections between structures.

4.1.3 Layout

Raceways shall not be located close to heat sources unless cables are selected or derated for the highest expected ambient temperature. Longitudinal expansion of raceways shall be considered in areas with varying temperatures.

The design of raceways shall accommodate the installation of qualified fire stops where raceways penetrate a fire barrier. For additional fire considerations, see IEEE Std 690-~~1984~~ [2004](#).

¹¹ [Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.](#)

¹² Information on references can be found in Clause 2.

4.2 Separation criteria

4.2.1 Design requirements

The design requirements for physical independence and separation of raceways containing Class 1E circuits are contained in IEEE Std 384-~~1992~~ [2008](#).

4.2.2 Raceways

Raceways shall be separated according to the voltage classification of the cables contained within them; see IEEE Std 690-~~1984~~ [2004](#).