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IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems

IEEE Power and Energy Society

Sponsored by the
Nuclear Power Engineering Committee

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IEEE Std 379™-2014
(Revision of
IEEE Std 379-2000)

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Abstract: Requirements for the application of the single-failure criterion to the electrical power, instrumentation, and control portions of nuclear power generating safety systems are provided in this standard.

Keywords: actuator, cascaded failure, common-cause failure, design basis event, detectable failure, effects analysis, IEEE 379™, nondetectable failure, safety system, single-failure criterion, system actuation, system logic

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Introduction

This introduction is not part of IEEE Std 379™-2014, IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems.

The requirement for nuclear power generating station safety systems to meet a single-failure criterion is found in many documents, including IEEE Standards, American Nuclear Society (ANS) standards, and federal regulations. It is the intention of this document to

- Conform specifically with the requirements of IEEE Std 603™-2009[a]
- Interpret the single-failure criterion as stated in IEEE Std 603-2009
- Provide guidance in the application of the single-failure criterion as stated in IEEE Std 603-2009

It is recognized that the single-failure criterion is applicable to the aggregate of electrical and mechanical systems. However, the criterion statement, as found in this document, has been developed for electrical systems. Where the interface with mechanical systems is unavoidable (e.g., sensing lines), the mechanical portions are considered to be part of the electrical system with which they interface. It should be noted that the systems include the actuation and protection systems, as well as the sense, command, and execute features of the power system (in accordance with IEEE Std 741™-2007, IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations.

The purpose of this revision to the standard is to

- Update the references cited in the text The standard working group has reviewed and identified that "indispensable" references are indeed in Clause 2, as the latest IEEE style manual (2014) directs. The remaining references have been included in the Bibliography (Annex A). This was included as part of the updating process for the standard.
- Verify that the terms not identified in the definitions of this standard (3.1) are identified in the IEEE-SA Standards Definition Database. The activity provides consistency with the latest direction in the IEEE Style Manual (2014)
- Update the standard as a result of changes in other standards resulting from other national and international standards development.
- Address any comments obtained from the user community since the issuance of IEEE Std 379-2000
- The design basis events subclause (5.4) was revised to clarify design basis events and the involvement of single failures. It does not change the definition and it clarifies that the analysis, previously mentioned, "shall" be done.
- The common-cause failures (CCFs) subclause (5.5) was revised to clarify the description of CCFs. Additional clarifying information added to to clearly state that "Common-cause failures and their failure mechanisms are not normally considered in a single-failure analysis ...."
- Subclause 6.1 was revised to include some of the material on probabilistic assessment from 6.3.2. It was also revised to further describe the systematic analysis that shall be performed to identify single failures and enhance the criteria to be used for the analysis.

[a] Information on references can be found in Clause 2.

— Subclause 6.3.2 was removed. Key content is now included in 6.1.

— To try to further promote the understanding of the concept of nondetectable failures and how they are identified differently than detectable failures, Annex B, Examples of Nondetectable Failures, was added. This Annex provides five examples of nondetectable failures in a wide range of applications and technologies used.

Several areas addressed by but not completely developed within this standard continue to evolve and may or may not have applicability to ongoing revisions to this standard:

— *Relationships with other guides and standards:* Other guides and standards should be incorporated in any good design to produce an acceptable and reliable system. The relationship of the single-failure criterion to these other guides and standards, documentation requirements, reliability and probability studies, testing, and operation is not within the scope of this standard.

— *Shared systems:* This revision of the standard describes the manner in which the single-failure criterion should be applied to shared systems. The intent is to neither endorse nor forbid the use of shared systems but rather to provide minimum requirements to assure that shared systems are analyzed as rigorously for the effects of component failures as they would be if sharing were not used.

— *Single operator error:* Operator actions should be considered, but are beyond the scope of this standard.

— *Common-cause failures:* The scope and purpose of this standard are focused on the application of single-failure criterion including the methods for the associated analysis and providing guidance for identification of these failure types. Common-cause failures and their mechanisms are not part of the scope and purpose of this standard. However, this revision illustrates, by the addition of a figure, the activity to screen CCFs from single failures.

In the future, separate development activities and standards on the subject of common-cause failure should propagate the level of importance of this subject, particularly as it continues to be a major concern in newer technologies. More specifically, comprehensive guidance, standards, and requirements should become more available on CCFs. One example of a standard that includes CCFs is IEEE Std 7-4.3.2™-2010, which addresses the analysis, the design techniques for prevention and the CCFs associated with systems that include computer hardware, software, firmware and interfaces. This will alleviate the inordinate amount of attention this standard receives on this subject if not just for discerning CCFs from single failure. Hopefully then, the future revision of this standard can point to documents that identify the requirements for all preventive measures of CCFs and the factors that they address. This standard then should not and will not be used to discern, analyze or identify CCFs or how to prevent CCFs from occurring.

Contents

IEEE Standard for Application of the Single-Failure Criterio n to Nuclear Power Generating Station Safety Systems

1. Overview

1.1 Scope

This standard covers the application of the single-failure criterion to the electrical power, instrumentation, and control portions of nuclear power generating station safety systems.

1.2 Purpose

The purpose of this standard is to interpret and provide guidance in the application of the single-failure criterion, discuss failures, and present an acceptable method of single-failure analysis. It is not the function of this standard to identify where the single-failure criterion is to be applied or to force compliance on any system; however, in those cases where the single-failure criterion has been invoked, this standard establishes the requirements for its application.