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Criteria for accident monitoring instrumentation for nuclear power generating stations

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Contents

CRITERIA FOR ACCIDENT MONITORING INSTRUMENTATION FOR NUCLEAR POWER GENERATING STATIONS

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The text of this standard is based on the following documents:

IEEE Std	FDIS	Report on voting
IEEE Std 497™-2016	45A/1167/FDIS	45A/1170/RVD

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IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations

Sponsor

Nuclear Power Engineering Committee
of the
IEEE Power and Energy Society

Approved 15 May 2016

IEEE-SA Standards Board

Abstract: Established in this standard are criteria for variable selection, performance, design, and qualification of accident monitoring instrumentation for anticipated operational, design basis events and severe accidents.

Keywords: accident monitoring, design criteria, display criteria, IEEE 497™, performance criteria, selection criteria, severe accidents, type variables

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IEEE Introduction

This introduction is not part of IEEE Std 497™-2016, IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations.

History

This standard evolved from IEEE Std 497™-2010 [B4][1]. It represents a continued effort by IEEE to support the specification, design, and implementation of accident monitoring instrumentation of nuclear power generating stations.

IEEE Std 497-2010 [B4] was developed to provide criteria for advanced instrumentation system designs and design modifications based on modern digital technology. It marked a clear path forward for the application of new technology. Though still maintaining applicability to existing systems, this version of IEEE Std 497 provides more current guidance based on historically related standards and guidance.

It was the working group's intention that the criteria of this standard address the variety of possible accident monitoring channel configurations that current technology affords. It was also the working group's intention to address the display of information using computer generated displays and calculated values. The criteria presented in this standard provide guidance in this area without limiting the types of displays that can be made available to accident management personnel.

Although written primarily for new plant designs, existing plants may also use the guidance and applicable criteria in this standard. The use of applicable plant procedures to determine the requirements of the accident monitoring instrumentation provides the necessary flexibility for useful design criteria. This standard can be used to help address the necessary changes to the plant configuration that occur over the operating life of any plant.

Historically the standard addressed accident monitoring instrumentation used for anticipated operating occurrences (AOOs) and design basis events (DBEs). To address lessons learned from various industry events, the scope of this standard has evolved to now include severe accidents. This evolution was intended to provide a broader applicability to cover both preventative and mitigative phases of potential plant events. A broader applicability of the standard was also achieved by moving to a more international, technology neutral approach to the standard. This approach was achieved by changing to International Atomic Energy Agency (IAEA) definitions of terms, where applicable; the removal, where appropriate, of U.S. specific references; and involvement in the working group of members of other standards organizations. Furthermore, the corresponding International Electrotechnical Commission (IEC) counterparts to the IEEE standards referenced were investigated and introduced as a second set of normative references. This opens the possibility to apply this standard in the IEC domain. The individual IEEE and IEC reference sets in whole are individually appropriate for use in the application of the standard, but inclusion of the IEEE and IEC references does not imply equivalency between the individual references of the two sets.

Intended use

The standard applies to instrumentation intended for use during anticipated operational occurrences (AOO), design basis events (DBE), and design extension conditions (DEC) including severe accidents.

This standard defines severe accidents as a subset of design extension conditions during which fuel damage has occurred. Operationally, severe accidents and design extension conditions without fuel damage are

[1] The numbers in brackets correspond to those of the bibliography in Annex D.

distinguished by the procedures and guidelines used to manage the event, with emergency operating procedures (EOP) used for design extension conditions without fuel damage and severe accident mitigation guidelines (SAMG) used for severe accidents (see Annex C).

The standard is to be applied to instruments designated for severe accidents (Type F variables); however, use of non-designated instruments during a severe accident is not precluded if these instruments are available and can aid in the accident mitigation. Design extension conditions that are not severe accidents are not covered by this standard.

This standard is intended to be used for both new plant designs and major modifications or upgrades of existing nuclear power generating stations. The standard can be applied to various reactor types used for power generation; however, development of the standard focused on light water reactors and application of the standard to reactor technologies beyond light water reactors should be evaluated prior to initial use.

Revision summary

Since IEEE Std 497 was approved in 2010, industry events have occurred that highlighted the need for the standard to address not just design basis events but severe accidents as well. The working group has considered and incorporated appropriate changes related to the following significant items:

— Lessons learned from industry events including Fukushima (earthquake and tsunami), Browns Ferry (tornado), Salem (loss of RPS due to CCF), and North Anna (earthquake)

— Accident monitoring instrument requirements based on emergency procedures and guidelines (EOPs and SAMGs)

— Reactor technology neutral approach

— International usability

— User feedback

— Requirements for severe accidents instrumentation

— IAEA definitions

Other minor editorial improvements throughout the standard were also incorporated.

Future work

As the use of digital technology in the nuclear plant is a dynamic area of design, the working group intends to keep this area as an ongoing future task.

Since no counterpart to this standard exists in the IEC domain, this standard was identified as a potential candidate for a dual-logo standard to be applied in both the IEEE and the IEC domain early in the course of this revision. A joint group of both organizations identified topics and aspects to be harmonized and recommended to proceed. Thus the recent revision was performed with the intent and the spirit to prepare and facilitate the application for the IEC domain. Formal involvement of the IEC was delayed. This revision of the standard is, therefore, still an IEEE standard, but may be further modified in the future after closer investigation by and discussion with IEC experts on its potential as a dual-logo standard.

Another area that the working group believes should be considered in a future revision to the standard is how to adopt risk-informed techniques into accident monitoring criteria.

Additionally, user feedback related to the implementation of the standard on non-light water reactors and implementation of Type F variables will be reviewed and considered for a future revision.

Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations

1. Overview

1.1 Scope

This standard contains the functional and design criteria for accident monitoring instrumentation for new plant designs and nuclear power generating stations desiring to perform design modifications.

1.2 Purpose

The purpose of this standard is to establish selection, design, performance, qualification, and display criteria for accident monitoring instrumentation for anticipated operational occurrences, design basis events, and severe accidents.

1.3 Application

This standard applies to accident monitoring instrumentation intended for use during the following operations:

— As required for planned operator action related to accident mitigation

— For assessing plant conditions, safety system performance, and making decisions related to plant response to abnormal events

— For achieving and maintaining safe shutdown following an accident

This standard does not apply to the following:

— Accident monitoring instrumentation that is intended solely for historical recording or solely for maintenance purposes

— Other instrumentation that may be available during accident conditions

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.

2.1 Normative references for IEEE domain

ASME NQA-1-2008, Quality Assurance Requirements for Nuclear Facility Applications.[2]

IEEE Std 7-4.3.2™-2016, IEEE Standard Criteria for Programmable Digital Devices in Safety Systems of Nuclear Power Generating Stations.[3,4]

IEEE Std 308™-2012, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.

IEEE Std 323™-2003, IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.

IEEE Std 344™-2013, IEEE Standard for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

IEEE Std 352™-1987, IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Stations.

IEEE Std 379™-2014, IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems.

IEEE Std 384™-2008, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.

IEEE Std 577™-2012, IEEE Standard Requirements for Reliability Analysis in the Design and Operation of Safety Systems for Nuclear Power Generating Stations.

IEEE Std 603™-2009, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.

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2.2 Normative references for IEC domain

IAEA GS-R-3:2006, The Management System for Facilities and Activities.[5]

IEC 60880:2006, Nuclear power plants—Instrumentation and control systems important to safety—Software aspects for computer-based systems performing category A functions.[6]

IEC 61225:2005, Nuclear power plants—Instrumentation and control systems important to safety—Requirements for electrical supplies.

IEC 60780:1998, Nuclear power plants—Electrical equipment of the safety system—Qualification.

IEC 60980:1989, Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations.

IEC 60812:2008, Analysis techniques for system reliability—Procedure for failure mode and effects analysis (FMEA).

IEC 62340:2007, Nuclear power plants—Instrumentation and control systems important to safety—Requirements for coping with common cause failure (CCF).

IEC 60709:2004, Nuclear power plants—Instrumentation and control systems important to safety—Separation.

[5] IAEA publications are available from the International Atomic Energy Agency, Vienna International Centre, PO Box 100, A-1400 Vienna, Austria

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