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IEEE Power and Energy Society

Developed by the
Nuclear Power Engineering Committee

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(Revision of IEEE Std 627-2010)

IEEE Standard for Qualification of Equipment Used in Nuclear Facilities

Developed by the

Nuclear Power Engineering Committee
of the
IEEE Power and Energy Society

Approved 5 September 2019

IEEE SA Standards Board

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Abstract: Guidance on basic qualification principles and appropriate methods of demonstrating the qualification of equipment used in nuclear facilities is provided in this standard. The principles, methods, and procedures described are intended to be used for qualifying equipment.

Keywords: equipment qualification, IEEE 627™, margin, qualification documentation, qualification program, safety, safety-related, service condition, significant aging mechanisms

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PDF: ISBN 978-1-5044-6141-2 STD23875
Print: ISBN 978-1-5044-6142-9 STDPD23875

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Introduction

This introduction is not part of IEEE Std 627-2019, IEEE Standard for Qualification of Equipment Used in Nuclear Facilities.

The safety classification of a structure, system, item of equipment, or component corresponds to its required function. Qualification is intended to demonstrate the capability of the equipment design to perform its required function(s) over the expected range of operational conditions, which could include normal, abnormal, design basis event, design extension condition, and in-service test conditions. The primary role of qualification is to provide reasonable assurance that design- and age-related common-cause failures will not prevent the performance of required function(s) under postulated service conditions. The level of qualification required directly depends on this classification. The pressure containment integrity and passive structural requirements of mechanical equipment covered by ASME, AISC or ACI codes are considered qualified by adherence to those codes. Qualification of electrical and instrumentation and control equipment whose required function is a safety function requires adherence to one or more IEEE standards.

The US requirements for qualification of safety system equipment are mandated by regulatory documents including the Code of Federal Regulations (CFR) and various industry standards. Among them are the following:

a) 10 CFR Part 50, Appendix A, General Design Criterion 2 (Design Bases for Protection Against Natural Phenomena) General Design Criterion 4 (Environmental and Dynamic Effects Design Bases), and General Design Criterion 23 (Protection System Failure Modes). This requires that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, … and to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant-accidents.

b) 10 CFR Part 50, Appendix B, Quality Assurance Criterion III (Design Control). This requires that design control measures be established and that such measures provide for verifying or checking the adequacy of design. One of the methods of design verification is by the performance of a suitable testing program.

c) 10 CFR Part 50.55a(h)(2) Codes and Standards, Protection Systems. This requires that the protection systems meet the requirements set forth in IEEE Std 279™-1968, Proposed IEEE Standard Criteria for Nuclear Power Plant Protection Systems, or the requirements in IEEE Std 279™-1971, IEEE Standard Criteria for Protection Systems for Nuclear Power Generating Stations, or the requirements in IEEE Std 603™-1991, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations, and the correction sheet dated January 30, 1995.

d) ANSI/ANS 58.14, Safety and Pressure Integrity Classification Criteria for Light Water Reactors.

e) IEEE Std 1819™, IEEE Standard for Risk-Informed Categorization and Treatment of Electrical and Electronic Equipment at Nuclear Power Generating Stations and Other Nuclear Facilities.

f) ANSI/ASME Boiler and Pressure Vessel (BPV) Code, Section III.

g) Clause 4.9, Equipment Qualification, of IEEE Std 308™, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.

h) Clause 5.4, Equipment Qualification, of IEEE Std 603, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.

i) Clause 5.4, Equipment Qualification, of IEEE Std 7-4.3.2™, IEEE Standard Criteria for Programmable Digital Devices in Safety Systems of Nuclear Power Generating Stations.

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This standard was written and continues to serve as a general standard for qualification of all types of mechanical, instrumentation, and electrical equipment. It establishes the high-level principles and procedures to be followed in preparing equipment-specific qualification standards. Additional detailed guidance for qualifying specific types of equipment is found in equipment-specific qualification standards, such as the daughter standards of IEC/IEEE 60780-323 or IEEE Std 7-4.3.2. Annex B provides an extensive, albeit not exhaustive, list of qualification-related references.

Efforts to develop a high-level design qualification standard were originally begun in late 1975 at the request of the IEEE Nuclear Standards Management Board. A joint ASME/IEEE agreement in 1977 assigned responsibility for qualification standards development to IEEE and quality assurance standards to ASME. In accordance with that agreement, IEEE completed the generic qualification standard, IEEE Std 627-1980, which provided high level approaches, criteria, guidance, and principles for qualification of both electrical and mechanical equipment that at the time appeared in no other industry standard. IEEE Std 627-1980 was reaffirmed in 1996.

In 1986, ASME's Board on Nuclear Codes and Standards directed its Committee on Qualification of Mechanical Equipment (QME) to develop a standard for qualifying active mechanical equipment. This task was completed in several parts during the time frame from 1992 to 1994. Partly in response to this activity, IEEE Std 627 was withdrawn in 2002.

Even after withdrawal IEEE Std 627 continued to be referenced in ASME's QME-1-2002 "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants" and the US NRC's NUREG-0800 Standard Review Plan Section 3.11. As a result, in 2007, the IEEE Standards Board authorized Working Group 2.10 of Subcommittee 2 (Qualification) of the Power and Energy Society's Nuclear Power Engineering Committee (NPEC) to resurrect and update the standard. The updated standard was published in 2010.

This revision of the standard is performed under the standard review cycle and is intended to reflect current user practices. The revision is focused on confirming the existing content of the standard with respect to outdated references, changes to the state-of-technology, and new operating experience and includes the following improvements.

— Revised the purpose statement and other relevant text to clarify that design extension conditions may be included in the scope of operational conditions that require qualification depending on the licensing basis of the facility.

— Added the following new definitions: beyond design basis event, Class 1E, condition indicator, condition-based qualification, design extension condition, embedded digital device, harsh environment, programmable digital device, and operational conditions.

— Updated the following definitions for consistency with usage in other NPEC standards: analysis, auditable data, code classes, equipment qualification, qualified condition, qualified life, and service condition.

— Added cross-reference to IEEE Std 1819 for risk-based classification of electrical equipment in 1.2.

— Added cross-reference to IEEE Std 7-4.3.2 for qualification of digital programmable devices, including, but not limited to, IEEE Std 1012 and P1891 for embedded/programmable digital device design.

— Updated discussion of aging and qualified life/qualified condition for consistency with IEC/IEEE joint qualification standards.

— Revised Figure 1 to further clarify the relationship between IEEE Std 627 and other qualification-related standards.

— Clarified that proprietary test results or data supporting qualification conclusions are not required to be included directly in the qualification file but must be retrievable during an audit.

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— Confirmed that Annex A remained consistent with usage of terminology in other NPEC standards.

— Updated Annex B to include more recently published qualification-related references.

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1. Overview

1.1 Scope

This standard provides the basic principles for qualification of equipment used in nuclear facilities; it does not define the scope of equipment requiring qualification nor does it provide guidance on how to classify equipment.

Other standards that present qualification methods for specific classifications of equipment, specific types of equipment, specific environments, or specific aspects of a qualification program may be used to supplement this standard, as applicable. The bibliography contains a partial list of references, including other standards, related to equipment qualification.

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1.2 Purpose

The purpose of this standard is to provide basic principles and guidance to demonstrate the qualification of equipment. Qualification is intended to confirm the adequacy of the equipment design to perform its required function or functions over the expected range of operational conditions, which could include any combination of normal, abnormal, design basis event, ~~post~~ design extension condition, or ~~basis event, and~~ in-service test conditions for which the equipment has a required function. The level of qualification depends on the nature of the required function; a required safety function necessitates a higher level of qualification than a function that is not classified as safety-related. See IEEE Std 603™ for additional guidance on the classification of electrical equipment.[1] For those facilities adopting a risk-informed categorization program, see IEEE Std 1819™ [B36] for additional guidance on the risk-informed classification of electrical and electronic equipment.[2]

1.3 Annexes

This standard includes an informative (non-mandatory) annex that clarifies ~~various terms related to~~ safety classification terminology ~~and~~ used by various organizations. Such terms include, but are not limited to safety, safety-related, Class 1E, Category 1, safety significant, and important to safety. The intent is that clarification of such terms will allow a facility owner to be able to make a more informed decision regarding which equipment needs to be qualified.

This standard ~~It~~ also includes an informative (non-mandatory) annex that describes references relevant to the creation of this standard and lists other standards related to equipment qualification.

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

[2] The numbers in brackets correspond to those of the bibliography in Annex B.

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