IEEE Standard for Qualification of Equipment Used in Nuclear Facilities

IEEE Power & Energy Society

Sponsored by the
Nuclear Power Engineering Committee

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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, margin, qualification documentation, qualification program, safety, safety related, service condition, significant aging mechanisms

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Introduction

This introduction is not part of IEEE Std 627-2010, IEEE Standard for Qualification of Equipment Used in Nuclear Facilities.

The 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, Codes and Standards, Protection System. This requires that the protection system meet the requirements set forth in 4.4 of IEEE Std 279™-1971 [B11].

d) ASME BPV-III, ASME Boiler and Pressure Vessel Code, Section III [B3].

e) Clause 4.7, Equipment Qualification, of IEEE Std 308™, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations [B12].

f) Clause 4.6, Equipment Qualification, of IEEE Std 603™, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.

g) Clause 3.3, Equipment Qualification, of ANSI/ANS-56.7-1978 (withdrawn 1997), Boiling Water Reactor Containment Ventilation Systems.

h) Clause 3.3, Component Performance Requirements, of ANSI/ANS-56.6-1986 (withdrawn 1996), Pressurized Water Reactor Containment Ventilation Systems.

i) Clause 4.6, Isolation Barrier Environmental Provisions, of ANSI/ANS-56.2-1984 (withdrawn 1999), Containment Isolation Provisions for Fluid Systems.

Efforts on this standard were originally begun in late 1975 at the request of the IEEE Nuclear Standards Management Board. In 1977 a joint ASME/IEEE agreement established responsibility for qualification and quality assurance standards preparation. ASME accepted responsibility for Quality Assurance and IEEE for qualification. In accordance with that agreement, IEEE completed the generic qualification standard which is this standard in 1980. This document provided high level approaches, criteria, guidance, and principles for qualification of both electrical and mechanical equipment that at that time appeared in no other industry standard. IEEE Std 627-1980 was later 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 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.

Later although withdrawn, it was found that IEEE Std 627 was continuing to be used and referenced by many entities both in the US and other countries including in ASME's QME-1-2002 "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," US NRC's NUREG-0800 Standard Review Plan Section 3.11 [B38], at least one reactor vendor's Design Certification Document (DCD), several

international licensing documents, and elsewhere. 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 to resurrect and update IEEE Std 627-1980 (R1996).

This revision has incorporated the following improvements to reflect current practices and user needs:

- The resulting standard is an upper tier document to both IEEE Std 323™ and ASME QME-1.
- Allowance for Owner discretion to apply this standard to other safety system equipment and to facilities other than nuclear power generating stations.
- The term design qualification has been replaced by equipment qualification or just qualification (because the term design qualification is not widely used).
- Deletions, additions to and updates in several of the definitions have been made (such as design qualification, equipment qualification, common mode and common cause failures, DBE Period of Operability, and margin).
- Minor changes in the names of Clause 5 and Clause 6 and rearranging of wording to match the clause titles have been made to facilitate future reference.
- An informative block diagram has been added to clarify the relationship between this standard and other qualification references.
- An informative annex clarifying various terms related to safety for possible use by facility Owners in determining when qualification should be invoked has been added.
- An informative bibliographical annex with a comprehensive list of qualification references has been added.

This standard was written and continues to serve as a general standard for qualification of all types of equipment, mechanical and instrumentation as well as electrical. It also establishes principles and procedures to be followed in preparing specific equipment standards. Guidance for qualifying specific types of equipment may be found in various equipment-specific qualification standards (see Annex B).

Equipment in nuclear facilities with required functions are required to meet or exceed performance requirements throughout its installed life. This is accomplished by a disciplined program of qualification and quality assurance of design, production, installation, maintenance and surveillance. This standard is for the qualification section of the program only. Normal production testing and preoperational testing (i.e., functional testing) performed after installation and acceptance of the equipment is outside the scope of this standard.

Qualification is intended to demonstrate the capability of the equipment design to perform its required function(s) over the expected range of normal, abnormal, design basis event, post design basis event, and in-service test conditions. Inherent to qualification is the requirement for demonstration, within limitations afforded by established technical state-of-the-art, that in-service aging throughout the qualified life established for the equipment will not degrade the equipment from its original design condition to the point where it cannot perform its required safety function(s) upon demand. The above requirement reflects the primary role of qualification to provide reasonable assurance that design- and age-related common cause failures will not occur during performance of required function(s) under postulated service conditions.

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Contents

IEEE Standard for Qualification of Equipment Used in Nuclear Facilities

1. Overview

1.1 Scope

This standard provides the basic principles for qualification of equipment used in nuclear facilities.

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 normal, abnormal, design basis event, post design basis event, and in-service test conditions.

1.3 Annexes

This standard includes an informative (non-mandatory) annex that clarifies various terms related to safety 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. 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.