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IEEE Trial-Use Standard: General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations

Sponsored by the
Joint Committee on Nuclear Power Standards
of the
IEEE Group on Nuclear Science
and the
IEEE Power Society

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Foreword

In the Code of Federal Regulations (10 CFR 50) the Atomic Energy Commission requires each applicant for a license to operate a nuclear power generating station to provide: "A preliminary analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from the operation of the facility and including determination of the adequacy of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents". The Institute of Electrical and Electronics Engineers has developed this document to provide guidance for demonstrating and documenting the adequacy of electric equipment used for these purposes (Class I Electric Equipment).

Adherence to this guide may not suffice for assuring public health and safety because it is the integrated performance of the structures, fluid systems, the instrumentation systems, and the electric systems of the station that limits the consequences of accidents. Each applicant has the responsibility to assure himself and others that this guide, if used, is pertinent to his application and that the integrated performance of his station is adequate.

Guidance for demonstrating the capability of specific equipment may be found in the following documents which are in preparation:

Proposed Guide for Type Tests of Modules Used in Nuclear Power Generating Stations Protection Systems, JCNPS/SC2.1

Proposed Guide for Type Tests of Class I Motors Installed Inside the Containment of Nuclear Power Generating Stations, JCNPS/SC2.2

Proposed Guide for Type Tests of Class I Valve Actuators Installed Inside the Containment of Nuclear Power Generating Stations, JCNPS/SC2.3

Proposed Guide for Type Tests of Class I Cables and Connections Installed Inside the Containment of Nuclear Power Generating Stations, JCNPS/SC2.4

Proposed Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations, JCNPS/SC2.5

Proposed Application Basis Criteria for Class I Electric Equipment for Nuclear Power Generating Stations, JCNPS/SC2.6

Proposed Guide for Seismic Qualification of Class I Switchgear and Switchgear Assemblies for Nuclear Power Generating Stations, JCNPS/SC2.7

Proposed Guide for Seismic Qualification of Class I Transformers for Nuclear Power Generating Stations, JCNPS/SC2.8

It is planned that the above documents will be approved as IEEE Standards and adopted as American National Standards.

Acknowledgment

The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge and who have conducted the theoretical and experimental work on which this publication is based. This document was prepared by Subcommittee SC2 — Equipment Qualification — of the IEEE Joint Committee on Nuclear Power Standards and approved by the JCNPS. At the time of final subcommittee approval, the members were:

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Notice of Trial Use.

Comments on this Trial-use Standard are welcomed and should be addressed to the Secretary, IEEE Standards Committee, 345 East 47th Street, New York, N.Y. 10017. After a trial-use period of approximately one year, the Group responsible for this document will prepare a revision and submit it to the Standards Committee for approval as a full-status standard.

IEEE Trial-Use Standard: General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations

1. Scope

This document describes the basic requirements for the qualification of Class I electric equipment. This is equipment which is essential to the safe shutdown and isolation of the reactor or whose failure or damage could result in significant release of radioactive material.

2. Purpose

The purpose of this document is to provide guidance for demonstrating the qualifications of electrical equipment as required in the IEEE Std 279 — Criteria for Nuclear Power Generating Station Protection Systems, and IEEE Std 308 — Criteria for Class IE Electric Systems for Nuclear Power Generating Stations.

The qualification methods described may be used in conjunction with the Guides for qualifying specific types of equipment, (see Foreword), for updating qualification following modifications or for qualifying equipment for which no applicable Guide exists.

3. Definitions

The definitions in this Section establish the meanings of words in the context of their use in this Guide.

qualification. Demonstration that equipment meets design requirements.

auditable data. Technical information which is documented and organized so as to be readily understandable and traceable to independently verify inferences or conclusions based on these records.

operating experience. Accumulation of verifiable service data for conditions equivalent to those for the equipment to be qualified.

analysis. A process of mathematical or other logical reasoning that leads from stated prem-

ises to the conclusion concerning specific capabilities of equipment and its adequacy for a particular application.

service conditions. Environmental, power and signal conditions expected as a result of normal operating requirements, expected excursions in operating requirements and postulated conditions appropriate for the design basis events of the station.

type tests. Tests made on one or more units to verify adequacy of design.

Other definitions related to this document may be found in:

IEEE Std 279 — Criteria for Nuclear Power Generating Station Protection Systems.

IEEE Std 308 — Criteria for Class IE Electric Systems for Nuclear Power Generating Stations.

4. Qualification

The qualification of Class I Electric Equipment shall include:

4.1 Identification of the Class I Electric Equipment being qualified.

4.2 Preparation of equipment specifications adequate for the application.

4.3 Demonstration that the equipment or components thereof are capable of meeting performance specifications under the service conditions. Type tests which simulate the service conditions are preferred for this demonstration. When size or other practical requirements limit or preclude type tests, the demonstration may be made by:

4.3.1 Augmenting partial type tests by analysis or operating experience, or both.

4.3.2 Analysis or operating experience, or both, that clearly demonstrate the required capability.

4.4 Preparation of documentation to permit an independent evaluation of the equipment qualification.

5. Method and Documentation

5.1 General. The qualification method shall establish that each type of equipment is qualified for its application. The documentation shall include: the application requirements, the equipment specifications and data from the qualification method used.

5.2 Type Test Data. Type test data used to demonstrate the qualification of equipment shall be pertinent to the application and organized in an auditable form.

The type test data shall contain:

5.2.1 The equipment specifications.

5.2.2 Identification of the specific features to be demonstrated by the type test.

5.2.3 The test program outline. Typically this test outline includes:

5.2.3.1 The service conditions and design basis event conditions to be simulated.

5.2.3.2 The variables to be measured including accuracy.

5.2.3.3 The number, type, and location of test monitoring sensors for each variable.

5.2.3.4 The static and dynamic performance characteristics.

5.2.3.5 The special conditions to be applied, for example, large signals, extreme power supply voltages, fire, water, seismic forces, radiation, chemical sprays, etc.

5.2.3.6 The range, sequence, and combinations of environment to simulate the design basis event conditions.

5.2.3.7 The equipment mountings relevant to performance.

5.2.3.8 The cable connections and other required appurtenances.

5.2.3.9 Acceptance criteria.

5.2.4 The test results (for each test)

5.2.4.1 Objective.

5.2.4.2 Equipment tested.

5.2.4.3 Test facility and instrumentation with traceability records.

5.2.4.4 Test procedures.

5.2.4.5 Test data and accuracy.

5.2.4.6 Summary, conclusions and recommendations.

5.2.4.7 Approved signature and date.

5.2.5 Supporting data.

5.2.6 Approved signature and date.

5.3 Operating Experience Data. Operating experience data used to demonstrate the qualifications of equipment shall be pertinent to the application and organized in an auditable form.

The operating experience data shall contain:

5.3.1 Specifications for the equipment to be qualified.

5.3.2 The specifications of equipment for which operating experience is available.

5.3.3 Identification of the specific features to be demonstrated by operating experience.

5.3.4 Comparison of past application and specifications with the new equipment specifications for each feature identified above.

5.3.5 Summary and source of operating experience applicable to equipment qualification.

5.3.6 The basis on which the data have been determined to be suitable.

5.4 Analysis. The data used to support the qualification of equipment by analysis shall be pertinent to the application and organized in an auditable form. The data shall be presented as a step-by-step description, so persons reasonably skilled in this type of analysis can follow the reasoning as well as the computations. The data shall contain:

5.4.1 The equipment specifications.

5.4.2 The interface or boundary conditions of the equipment.

5.4.3 The specific features, postulated failure modes, or the failure effects to be analyzed.

5.4.4 The assumptions, empirically derived values, and mathematical models used together with appropriate justification for their use.

5.4.5 Description of analytical methods or computer programs used.

5.4.6 A summary of analytically established performance characteristics.

5.4.7 Approved signature and date.

5.5 Extrapolation. Where the type test data or operating experience data have been extrapolated, the basis for the extrapolation shall be included.

6. Modifications

Each modification to the equipment or to the equipment specification made subsequent to the start of the type test or beginning of the operating experience reporting period shall be evaluated to determine its effect on the equip-

ment qualification. This evaluation shall indicate whether or not re-qualification is required. The analysis or data and evaluation that demonstrates the effect of the modification on equipment performance shall be added to the qualification documentation.