



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

3.11 ENVIRONMENTAL QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

REVIEW RESPONSIBILITIES

Primary - Equipment Qualification Branch (EQB)

Secondary - None

I. AREAS OF REVIEW

The information presented in Section 3.11 of the applicant's safety analysis report (SAR) should be sufficient to support the conclusion that all items of equipment (mechanical, electrical, includes instrumentation and control) are capable of performing their design safety functions under all normal, abnormal, and accident environmental conditions. The review will be performed to assure conformance with the requirements of 10 CFR Part 50, Appendix A, General Design Criterion 4. The "normal, abnormal, accident and post accident environmental conditions" are deemed to include all environmental conditions which may result from any normal or abnormal mode of plant operation, design basis events, post-design basis events, and containment tests. Mechanical and electrical equipment associated with systems described below must be designed to meet the requirements as described under the acceptance criteria of this SRP section. Mechanical and electrical equipment covered by this SRP section includes equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are essential in preventing significant release of radioactive material to the environment. Also covered by this SRP section is equipment (1) that performs the above functions automatically, (2) that is used by the operators to perform these functions manually, and (3) whose failure can prevent the satisfactory accomplishment of one or more of the above safety functions. Seismic qualification is addressed in SRP Section 3.10.

Section 3.11 of the SAR is reviewed to determine whether the required environmental capability of all equipment, i.e., the capability to perform design safety functions under normal, abnormal, accident, and postaccident environments, will be or has been adequately demonstrated.

At the construction permit (CP) stage the staff review will consider the conceptual approach addressing the following areas:

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

1. Identification of all mechanical and electrical systems required to perform the functions defined in paragraph 1 of subsection I.
2. Identification of the environmental design bases for the equipment identified including the definition of the normal, abnormal, accident and post-accident environments.
3. Requirement for documentation of the qualification tests and analyses that have been or will be performed on the equipment to meet the design bases.
4. Demonstration of the adequacy of the environmental qualification program.

At the operating license (OL) stage the staff reviews the applicant's environmental qualification program and the submitted results of its implementation. The staff additionally will audit the applicant's central file. The audit consists of a staff review of the documentation provided in the file to demonstrate tangible evidence of qualification.

The staff's review is performed to determine proper implementation of criteria established in the CP review, and adequate environmental qualification for all mechanical and electrical equipment.

Although the EQB has the primary responsibility for the review of this section, the EQB reviewer utilizes the information from other SAR sections which are reviewed by other branches in the performance of their review functions. EQB will coordinate other branches evaluation that interface with the overall review of equipment qualification as follows:

The SAR sections reviewed by the branches in performance of their review functions are as follows: ASB reviews Sections 3.4.1, 3.5.1.1, 3.5.2, 3.6.1, 5.4.11, and applicable sections of Chapter 9; CSB reviews Section 6.2; RSB reviews Sections 5.4.6, 5.4.7, 6.3, and applicable sections of Chapter 15; ICSB reviews Chapter 7, PSB reviews Chapter 8, and AEB reviews Section 6.5.2.

The ASB, ICSB, PSB, and RSB confirm that the SAR identifies all equipment as identified in paragraph 1 of subsection I.

The ASB and CSB confirm the location of each item of equipment, both inside and outside the containment. Inside the containment, the location must be specified, whether inside or outside of the missile shield for pressurized water reactor (PWR) plants, or whether inside or outside of the drywell for boiling water reactor (BWR) plants.

The ASB, CSB, ICSB, PSB, and RSB confirm the validity of the descriptions of the normal, abnormal, accident, and postaccident environments provided in the SAR. They will also confirm the acceptability of the values provided in the SAR for the length of time that equipment is required to operate in accident environments.

With regard to the environments resulting from loss of environmental control systems (ventilation, heating, air conditioning), the ASB will confirm the

description of these environments as provided in the SAR for those areas which contain equipment including electrical control and instrumentation equipment.

The QAB reviews and determines that the applicant's QA program described in Chapter 17 of the SAR satisfies the requirements of 10 CFR 50, Appendix B, Criteria III, XI, and XVII.

The AEB reviews the adequacy of the radiation and chemical conditions for qualification for the abnormal, accident, and postaccident environments.

Specific information may be requested from the MEB as needed.

For those areas of review identified above as being reviewed as part of the primary responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

The general requirements for environmental design and qualification of all equipment are embodied in General Design Criterion 4 of Appendix A to 10 CFR Part 50.

Specific criteria, task action plan items, regulatory guide, and industry standards that provide information, recommendations and guidance and, in general, describes a basis acceptable to the staff that may be used to implement the requirements of General Design Criterion 4 are as follows:

Simply stated, the general requirements for environmental design and qualification are as follows: (1) The equipment shall be designed to have the capability of performing its design safety functions under all normal, abnormal, accident, and postaccident environments and for the length of time for which its function is required. (2) The equipment environmental capability shall be demonstrated by appropriate testing and analyses. (3) A quality assurance program meeting the requirements of 10 CFR 50 Appendix B shall be established and implemented to provide assurance that all requirements have been satisfactorily accomplished. The environmental design of mechanical and electrical equipment is acceptable when it can be ascertained that all three requirements are met.

At the time of the CP and DL application, complete and auditable records must be available and maintained at a central location which describe the environmental qualification method used for all mechanical and electrical equipment in sufficient detail to document the degree of compliance with the requirements discussed herein. Thereafter, such records should be updated and maintained current as equipment is replaced, tested, or otherwise qualified.

Harsh Environment

The specific criteria for assessing the acceptability of the environmental qualification program of OL applicants are provided in NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," issued in December 1979. NUREG-0588 includes two sets of qualification requirements, Category I and Category II, which relate to IEEE 323-1974

and 1971 respectively. Category II is for plants whose construction permit SERs were dated before July 1, 1974 unless the licensee made a commitment in the construction permit record to use the 1974 standard, or unless the operating license application indicates the 1974 standard is to be used in which case, Category I will be the applicable criteria to be used. Category I is for plants whose construction permit SERs were dated after July 1, 1974.

Subsection VI lists the documents which provide both acceptance criteria and evaluation guidance used in the review. The most important of these documents is IEEE Std 323 (augmented by Regulatory Guide 1.89), "General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations." This document, although specifically written for Class I electric equipment, contains a clear presentation of the principles and criteria that are generic to the environmental qualification process itself; therefore, IEEE Std 323 is considered applicable to the environmental qualification of other types of equipment. This document contains detailed criteria applicable to whatever method of qualification is used, i.e., type testing, analyses, operating experience, on-going qualification, or combined qualification. NUREG-0588 (endorsed by the Commission Memorandum and Order CLI-80-21 dated May 23, 1980), "Interim Staff Position on Electrical Equipment," discusses the staff position and acceptance criteria on the environmental qualification of electrical equipment. These criteria are general in nature and could also be applied to the mechanical equipment. The environmental design and qualification of equipment is acceptable when it is ascertained that the criteria of NUREG-0588 have been met.

IEEE Std 334, "Guide for Type Tests of Continuous-Duty Class I Motors Installed Inside the Containment of Nuclear Power Generating Stations" (augmented by Regulatory Guide 1.40); IEEE Std 382, "Guide for Type Test of Class I Electric Valve Operators for Nuclear Power Generating Stations" (augmented by Regulatory Guide 1.73); and IEEE Std 383, "Standard for Type Test of Class I Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations" (augmented by Regulatory Guide 1.131), are specific with regard to type test qualification of the equipment identified in their titles. The detailed criteria contained in these documents as they relate to environmental qualification should be used in conjunction with the more comprehensive criteria of NUREG-0588 for evaluating the respective equipment environmental qualifications.

IEEE Std 317, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations" (augmented by Regulatory Guide 1.63), contains general guidance for qualification of penetration assemblies. Therefore, this document as it relates to environmental qualification should be used in conjunction with NUREG-0588 for evaluating the environmental qualification of this equipment.

In addition, IEEE Standards 381, 535, 627, 649, and 650 can be used for guidance purposes even though NRC has not formerly endorsed these standards through the issuance of a Regulatory Guide.

The effects of the chemicals should be addressed for the equipment qualification. The concentration of chemicals used for qualification should be equivalent to or more severe than that resulting from the most limiting mode of plant operation (e.g., containment spray, ECCS initiation, or recirculation phase). If the chemical composition of the chemical spray can be affected by equipment malfunctions, the most severe chemical environment that results from a single failure in the spray system should be assumed. If only demineralized water

spray is used then the effect of the demineralized water spray should be included in the equipment qualification.

Radiation dose and dose rate used to determine the radiation environment for qualification of electrical and mechanical equipment shall be based on NRC staff approved source term and methodology as discussed in NUREG-0588 and supplemented by Section II.B.2 of NUREG-0737 and NUREG-0718. The radiation environment shall be based on the integrated effects of the normally expected radiation environment over the equipment's installed life plus that associated with the most severe design basis event during or following which the equipment is required to remain functional. Effects of the beta radiation shall also be considered in the qualification program. Effect of recirculatory fluid shall be considered for the equipment located outside the containment.

MILD ENVIRONMENT

The environmental qualification of all electrical and mechanical equipment located in the mild environment is acceptable if the following procedure is followed:

The documentation required to demonstrate qualification of equipment in a mild environment are the "Design/Purchase" specifications. The specifications shall contain a description of the functional requirements for its specific environmental zone during normal and abnormal environmental conditions. A well supported maintenance/surveillance program in conjunction with a good preventive maintenance program will suffice to assure that equipment that meets the design/purchase specifications is qualified for the designed life.

Furthermore the maintenance/surveillance program data and records shall be reviewed periodically (not more than 18 months) to ensure that the design qualified life has not suffered thermal and cyclic degradation resulting from the accumulated stresses triggered by the abnormal environmental conditions and the normal wear due to its service condition. Engineering judgment shall be used to modify the replacement program and/or replace the equipment as deemed necessary.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below as may be appropriate for a particular case. The reviewer obtains and uses information from SAR Chapters 4, 5, 6, 7, 8, 9, 10, 11, 15, and 17 and consults with other branches as necessary to be assured that the proper environmental parameters are being used for the equipment qualification.

For each area of review the following procedures are used:

- (1) At the CP stage, the staff reviews the program which the applicant has described in the PSAR for the environmental qualification of the mechanical and electrical equipment. The program is measured against the requirements listed in subsection II. Of particular interest to the reviewer are the proper use of test and analytical procedures. Equipment should be tested unless testing of the component is impractical due to size limitations or partial type test data is provided to support the analytical assumptions

and conclusions reached. The qualification is reviewed for the identification of normal, abnormal, accident, and postaccident environmental conditions, required operating time, chemical, and submergence, aging, and margin considerations, including the acceptance criteria of the test results.

- (2) At the OL stage, the staff reviews the program again as described by the applicant in the FSAR. In addition, the FSAR is reviewed for documentation of the successful implementation of the environmental qualification program including test and analytical results. The reviewer verifies that the applicant's list of systems, which includes the list of equipment associated with each such system, is consistent with the definition of the systems and equipment as delineated in paragraph 1 of subsection I.

To confirm the extent to which the equipment meets the requirements of subsection II, the staff audits the equipment qualification file and conducts a plant site review. For selected equipment, the staff reviews the test procedure and test results, and examines the equipment configuration and mounting, and then determines whether the test or analysis referenced demonstrates compliance with the established criteria.

The staff may require that component evaluation work sheets (CES) for all equipment be submitted to the staff. During its review, the staff will audit the central file and conduct a site visit. After the visit, the applicant may be required to submit certain selected documents and reports for further staff review. If the staff has reviewed an applicant's qualification file for a previous application, they may elect not to require the applicant to submit all the qualification summary data sheets, but instead elect to audit the qualification files at the applicant's central storage location.

IV. EVALUATION FINDINGS

The review should verify that sufficient information is contained in the SAR to support conclusions of the following type, to be included in the staff's safety evaluation report:

The staff concludes that the environmental qualification of mechanical and electrical equipment is acceptable and meets the relevant requirements of General Design Criterion 4 with respect to systems and components being designed to withstand the effects of and being capable of performing their safety function in the environmental conditions associated with normal operation, maintenance, testing, and accident conditions. This conclusion is based on the following:

The applicant has implemented an environmental qualification program that provides adequate assurance that mechanical and electrical equipment will function as intended in the normal, abnormal, and post-accident environmental conditions. The applicant's program for equipment has met the guidelines of task action plan, Item II.B.2 of NUREGs-0718 and 0737, IEEE-323 as supplemented by Regulatory Guide 1.89, IEEE-334 as supplemented by Regulatory Guide 1.40, IEEE-382 as supplemented by Regulatory Guide 1.73, IEEE-383 as supplemented by Regulatory Guide 1.63 and NUREG-0588.

V. IMPLEMENTATION

This section is intended to provide guidance to applicants and licensees regarding the NRC staff's plan for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative for complying with specific portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules to assure conformance to the method discussed herein are contained in the referenced regulatory guides and NUREGs. Plants are required to have a complete equipment qualification file that demonstrates compliance with this review plan (or uses established basis for alternate requirements) either by June 30, 1982 or prior to submittal of operating license application, whichever comes later.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."
2. 10 CFR Part 50, Appendix B, Criterion III, "Design Control"; Criterion XI, "Test Control"; and Criterion XVII, "Quality Assurance Records."
3. IEEE Std 279 (ANSI N42.7-1972), "Criteria for Protection Systems for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
4. IEEE Std 317, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generation Stations," Institute of Electrical and Electronics Engineers.
5. IEEE Std 323, "Standard for Qualifying Class 1E Equipment Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
6. IEEE Std 334, "Standard for Type Tests of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
7. IEEE Std 381, "Standard Criteria for Type Tests of Class 1E Modules Used in Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
8. IEEE Std 382, "Standard for Qualification of Safety-Related Valve Actuators," Institute of Electrical and Electronics Engineers.
9. IEEE Std 383, "Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
10. IEEE Std. 535, "Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.

11. IEEE Std. 627, "Standard for Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Station," Institute of Electrical and Electronics Engineers.
12. IEEE Std. 649, "Standard for Qualifying Class 1E Motor Control Centers for Nuclear Power Generating Stations."
13. IEEE Std. 650, "Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers.
14. Regulatory Guide 1.40, "Qualification Tests of Continuous Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants" (this guide supplements IEEE Std. 334).
15. Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Plants" (this guide supplements IEEE Std 317).
16. Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants" (this guide supplements IEEE Std 382).
17. Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants" (this guide supplements IEEE Std 323).
18. Regulatory Guide 1.131, "Qualification Tests of Electric Cables, Field Spices, and Connections for Light-Water-Cooled Nuclear Reactors" (this guide supplements IEEE Std 383).
19. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment."
20. NUREG-0737, "Clarification of TMI Action Plan Requirements."
21. NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing License."