

## Environmental Qualification of Equipment

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### Abstract

Specific requirements pertaining to the environmental qualification of electric equipment important to safety are contained in Section 50.49 of 10 CFR Part 50. One of the requirements of this rule is that documentation which shows the equipment is environmentally qualified must be maintained in an auditable form.

Over the past several years, the nuclear industry has been working to demonstrate compliance with the NRC's requirements regarding environmental qualification of electric equipment. Concurrently, the NRC staff has been reviewing and evaluating those efforts in order to assure such compliance. This task has involved a very significant amount of effort on the part of both the industry and staff.

Environmental qualification of safety-related mechanical equipment is discussed, including current staff criteria for newer plants and potential future application for operating plants.

### 1. Introduction

Equipment which is used to perform a necessary safety function must be demonstrated to be capable of maintaining functional operability under all service conditions postulated to occur during its installed life for the time it is required to operate. This requirement, which is embodied in General Design Criteria 1 and 4 of Appendix A and Sections III, XI, and XVII of Appendix B to 10 CFR 50, is applicable to equipment located inside as well as outside containment. More detailed requirements and guidance relating to the methods and procedures for demonstrating this capability for electrical equipment have been set forth in 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment" (which supplements IEEE Standard 323 and various NRC

Regulatory Guides and industry standards), and "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors" (DOR Guidelines).

On February 8, 1979, the NRC Office of Inspection and Enforcement (IE) issued to all licensees of operating plants (except those included in the systematic evaluation program (SEP)) IC Bulletin (IEB) 79-01, "Environmental Qualification of Class 1E Equipment." This Bulletin, together with IE Circular 78-08 (issued on May 31, 1978), required the licensees to perform reviews to assess the adequacy of their environmental qualification programs.

On January 14, 1980, NRC issued IEB 79-01B which included the DOR Guidelines and NUREG-0588 as attachments 4 and 5, respectively. Subsequently, on May 23, 1980, Commission Memorandum and Order CLI-80-21 was issued and stated that the DOR Guidelines and portions of NUREG-0588 form the requirements that licensees must meet regarding environmental qualification of safety-related electrical equipment in order to satisfy those aspects of 10 CFR 50, Appendix A, General Design Criterion (GDC) 4. Supplements to IEB 79-01B were issued for further clarification and definition of the staff's needs. These supplements were issued on February 29, September 30, and October 24, 1980.

In addition, the staff issued orders dated August 29, 1980 (amended in September 1980) and October 24, 1980 to all licensees. The August order required that the licensees provide a report, by November 1, 1980, documenting the qualification of safety-related electrical equipment. The October order required the establishment of a central file location for the maintenance of all equipment qualification records. The central file was mandated to be established by December 1, 1980. The staff subsequently issued Safety Evaluation Reports (SERs) on environmental qualification of safety-related electrical equipment to the licensees in 1981. These SERs directed the licensees to "either provide documentation of the missing qualification information which demonstrates that safety-related equipment meets the DOR Guidelines or NUREG-0588 requirements or commit to a corrective action (requalification, replacement (etc.))." The licensees were required to respond to NRC within 90 days of receipt of the SER. In response to the staff SERs issued in 1981, the licensees submitted additional information regarding the qualification of safety-related equipment. This information was evaluated for the staff by the Franklin Research Center (FRC) in order to: 1) identify all cases where the licensee's response did not resolve the significant qualification issues, 2) evaluate the licensee's qualification documentation in accordance with established criteria to determine which equipment had adequate documentation and which did not, and 3) evaluate the licensee's qualification documentation for safety-related electrical equipment located in harsh environments required for TMI Lessons Learned Implementation. Technical Evaluation Reports (TERs) were issued by FRC and Safety Evaluation Reports were subsequently issued to the licensees with the FRC TER as an attachment.

A final rule on environmental qualification of electric equipment important to safety for nuclear power plants became effective on February 22, 1983. This rule, Section 50.49 of

10 CFR 50, specifies the requirements to be met for demonstrating the environmental qualification of electrical equipment important to safety located in a harsh environment. In accordance with this rule, for most operating plants equipment may be qualified to the criteria specified in either the DOR Guidelines or NUREG-0588, except for replacement equipment. Replacement equipment installed subsequent to February 22, 1983 must be qualified in accordance with the provisions of 10 CFR 50.49, using the guidance of Regulatory Guide 1.89, unless there are sound reasons to the contrary.

A meeting was held with each licensee of plants for which a TER had been prepared for the staff by FRC in order to discuss all remaining open issues regarding environmental qualification, including acceptability of the environmental conditions for equipment qualification purposes, if this issue had not yet been resolved. These meetings were held to discuss proposed methods to resolve the environmental qualification deficiencies identified in the staff SERs and the FRC TERs. Discussions also included the methodology for compliance with 10 CFR 50.49, and the justification for continued operation for those equipment items for which environmental qualification was not yet completed. The minutes of the meetings and proposed method of resolution for each of the environmental qualification deficiencies were documented in submittals from the licensees.

## 2. Proposed Resolutions of Identified Deficiencies

The proposed resolutions for the equipment environmental qualification deficiencies, identified in the SERs, and the FRC TER enclosed with it, were described in the licensees' submittals. During the meetings with the licensees, the staff discussed the proposed resolution of each deficiency for each equipment item identified in the FRC TER and the licensees' approach for resolving the identified environmental qualification deficiencies was generally found to be acceptable. The majority of deficiencies identified were documentation, similarity, aging, qualified life and replacement schedule. All open items identified in the SERs were also discussed and the resolution of these items were generally found to be acceptable by the staff.

The approach described by the licensees for addressing and resolving the identified deficiencies included replacing equipment, performing additional analyses, utilizing additional qualification documentation beyond that reviewed by FRC, obtaining additional qualification documentation, installing radiation shielding, and determining that some equipment is outside the scope of 10 CFR 50.49, and therefore not required to be environmentally qualified, e.g., located in a mild environment. The staff discussed the proposed resolutions in detail on an item by item basis with the licensees during the meetings. Replacing, shielding or exempting equipment, for an acceptable reason, were clearly acceptable methods for resolving environmental qualification deficiencies. The more lengthy discussions with the licensees concerned the use of additional analyses or documentation. Although the staff did not review the additional analyses or documentation, it discussed how analysis was being used to resolve deficiencies identified in the FRC TER, and the content of the additional documentation in order to determine the acceptability of these methods. The

licensees' equipment environmental qualification files will be audited by the staff during follow-up inspections to be performed by the Regions, with assistance from IE Headquarters and NRR staff as necessary. A pilot program involving two inspections in each of the five Regions is currently in progress.

The primary objective of the file audit will be to verify that the equipment files contain the appropriate analyses and other necessary documentation to support the licensee's conclusion that the equipment is qualified. The inspections will verify that the licensee's program for surveillance and maintenance of environmentally qualified equipment is adequate to assure that this equipment is maintained in the as analyzed or tested condition. The method used for tracking periodic replacement parts, and implementation of the licensee's commitments and actions, e.g., regarding replacement of equipment, will also be verified.

3. Compliance With 10 CFR 50.49 For Electrical Equipment in a Harsh Environment

In their submittals, the licensees described the approach used to identify equipment within the scope of paragraph (b)(1) of 10 CFR 50.49, equipment relied upon to remain functional during and following design basis events. Design basis events which could potentially result in a harsh environment, including flooding outside containment, were addressed in identifying safety-related electrical equipment within the scope of 10 CFR 50.49(b)(1). Development of the safety-related electric equipment list was based on reviews of the Final Safety Analysis Report (FSAR), Technical Specifications, Emergency Operating Procedures, Piping and Instrumentation Diagrams (P&IDs), and electrical distribution diagrams.

The method used by the licensees for identification of electrical equipment within the scope of paragraph (b)(2) of 10 CFR 50.49, nonsafety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions, is summarized below:

1. A list was generated of safety-related electric equipment as defined in paragraph (b)(1) of 10 CFR 50.49 required to remain functional during or following design-basis Loss of Coolant Accident (LOCA) or High Energy Line Break (HELB) Accidents. The LOCA/HELB accidents are the only design-basis accidents believed to result in significantly adverse environments to electrical equipment which is required for safe shutdown or accident mitigation. The list was based on reviews of the Final Safety Analysis Report (FSAR), Technical Specifications, Emergency Operating Procedures, Piping and Instrumentation Diagrams (P&IDs), and electrical distribution diagrams;
2. The elementary diagrams of the safety-related electrical equipment identified in Step 1 were reviewed to identify auxiliary devices electrically connected directly into the control or power circuitry of the safety-related equipment (e.g., automatic trips) whose

failure due to postulated environmental conditions could prevent required operation of the safety-related equipment and;

3. The operation of the safety-related systems and equipment were reviewed to identify directly mechanically connected auxiliary systems with electrical components which are necessary for the required operation of the safety-related equipment (e.g., cooling water or lubricating systems). This involved the review of P&IDs, component technical manuals, and/or systems descriptions in the FSAR.
4. Nonsafety-related electrical circuits indirectly associated with the electrical equipment identified in Step 1 by common power supply or physical proximity were considered by a review of the electrical design including the use of applicable industry standards (e.g., IEEE, NEMA, ANSI, UL, and NEC) and the use of properly coordinated protective relays, circuit breakers, and fuses for electrical fault protection.

With regard to paragraph (b)(3) (certain post-accident monitoring equipment) of 10 CFR 50.49, the licensees confirmed that the electrical equipment within the scope of 10 CFR 50.49(b)(3) is R.G. 1.97 Category 1 and 2 equipment. Justification for not requiring environmental qualification of any such equipment was, or will be, provided as part of the licensees' programs for conformance to R.G. 1.97. The staff is currently reviewing these programs and will determine the acceptability of the justifications as part of that review.

#### 4. Justification for Continued Operation

The licensees provided justification for continued operation addressing each item of equipment for which the environmental qualification was not yet completed. The criteria used by the staff to evaluate the JCO's are listed below:

- a. The safety function can be accomplished by some other designated equipment that is qualified, and failure of the principal equipment as a result of the harsh environment will not degrade other safety functions or mislead the operator.
- b. Partial test data that does not demonstrate full qualification, but provides a basis for concluding the equipment will perform its function. If it can not be concluded from the available data that the equipment will not fail after completion of its safety function, then that failure must not result in significant degradation of any safety function or provide misleading information to the operator.
- c. Limited use of administrative controls over equipment that has not been demonstrated to be fully qualified. For any equipment assumed to fail as a result of the accident environment, that failure must not result in significant degradation of any safety function or provide misleading information to the operator.

## 5. Safety-Related Mechanical Equipment

Although there are no detailed environmental qualification requirements for mechanical equipment, GDC 1, "Quality Standards and Records," and 4, "Environmental and Missile Design Bases," and Appendix B to 10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" (Sections III, "Design Control," and XVII, "Quality Assurance Records"), contain the following requirements related to equipment qualification:

- Components shall be designed to be compatible with the postulated environmental conditions, including those associated with LOCAs.
- Measures shall be established for the selection and review for suitability of application of materials, parts, and equipment that are essential to safety-related functions.
- Design control measures shall be established for verifying the adequacy of design.
- Equipment qualification records shall be maintained and shall include the results of tests and materials analyses.

For mechanical equipment in plants recently, and currently being, licensed, the staff review concentrates on materials which are sensitive to environmental effects, for example, seals, gaskets, lubricants, fluids for hydraulic systems, diaphragms, etc. Applicants perform a review and evaluation that includes the following:

- (1) Identification of safety-related mechanical equipment located in harsh environment areas, included required operating time.
- (2) Identification of non-metallic subcomponents of this equipment.
- (3) Identification of the environmental conditions this equipment must be qualified for. The environments defined in the electrical equipment program are also applicable to mechanical equipment.
- (4) Identification of non-metallic material capabilities.
- (5) Evaluation of environmental effects.

With regard to environmental qualification of mechanical equipment in operating plants, the staff will evaluate the need for requiring that licensees perform the same review and evaluation, based on the results of those programs by applicants.

## 6. Current Status of Environmental Qualification

The NRC issued Generic Letter 84-24 (Certification of Compliance to 10 CFR 50.49), dated December 27, 1984, to all licensees of operating reactors and applicants for an operating license. The Commission directed the staff to collect information on the status of compliance with the rule, evaluate the information and make recommendations on any needed action. Accordingly, each licensee of an operating reactor was required to certify that: (a) the utility has in place and is implementing an Environmental Qualification (EQ) Program that will satisfy the requirements of 10 CFR 50.49 within the currently approved schedule for the plant without further extension; (b) the plant has at least one path to safe shutdown using fully qualified equipment, or has submitted a justification for continued safe operation (JCO) pending full qualification of any equipment not fully qualified; and (c) all other equipment within the scope of 10 CFR 50.49 is either fully qualified or a JCO has been submitted pending full qualification. The certifications described in (a), (b) and (c) above were to specifically address all IE Bulletins and Information Notices that identify EQ problems, to the extent that such bulletins and notices are relevant to the licensee's facility.

The staff is currently evaluating the licensees' responses to Generic Letter 84-24 and will make recommendations on needed action to the Commission.