



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

April 14, 1995

MEMORANDUM TO: Ashok C. Thadani, Associate Director
for Technical Assessment

FROM: Gary M. Holahan, Director *[Signature]*
Division of Systems Safety and Analysis

SUBJECT: RESULTS OF THE REVIEW OF NRC AUDIT/INSPECTION PRACTICES
(EQ-TAP ACTION ITEM 3.e) (TAG. M88848)

As discussed in the staff's Environmental Qualification Task Action Plan (EQ-TAP) of June 16, 1993, we are performing a programmatic review of environmental qualification (EQ) for electrical equipment. Our efforts in this regard are specifically defined under Action Item 3 of the EQ-TAP, which includes the following elements:

- 3.a Review License Renewal Background Information
- 3.b Review Fire Protection Reassessment Report
- 3.c Elicit Opinions from Others (Regions, EQ Experts)
- 3.d Review Existing EQ Program Requirements
- 3.e Review NRC Audit/Inspection Practices
- 3.f Review Licensee Implementation Practices
- 3.g Finalize Review Results

Our objective in completing Items 3.a through 3.f (above) is to identify potential EQ issues and concerns that may deserve further staff consideration. It is important to recognize that this part of our programmatic review is not intended to resolve or to otherwise address any of the EQ issues that are identified. After Items 3.a through 3.f of the EQ-TAP have been completed, all of the EQ issues will be consolidated and specifically addressed in the staff's final report under Item 3.g, "Finalize Review Results," which will include recommendations as appropriate.

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RETURN TO REGULATORY CENTRAL FILES

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The purpose of this memo is to inform you that we have completed our review associated with item 3.e of the EQ-TAP, "Review of NRC Audit/Inspection Practices," and our evaluation is attached for your information. The potential issues that were identified during this review will be assembled and addressed in our final report along with the other potential issues that have been identified. Having completed EQ-TAP Action Items 3.a through 3.f, we are now preparing our final report which will summarize the results of our EQ programmatic review and make recommendations for addressing substantive issues. Please contact me if you should have any questions regarding the attached evaluation.

Attachment:
Review of EQ Audit/Inspection Practices

The purpose of this memo is to inform you that we have completed our review associated with Item 3.e of the EQ-TAP, "Review of NRC Audit/Inspection Practices," and our evaluation is attached for your information. The potential issues that were identified during this review will be assembled and addressed in our final report along with the other potential issues that have been identified. Having completed EQ-TAP Action Items 3.a through 3.f, we are now preparing our final report which will summarize the results of our EQ programmatic review and make recommendations for addressing substantive issues. Please contact me if you should have any questions regarding the attached evaluation.

Attachment:
Review of EQ Audit/Inspection Practices

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REVIEW OF EQ AUDIT AND INSPECTION PRACTICES

1.0 INTRODUCTION

As discussed in the staff's Environmental Qualification Task Action Plan (EQ-TAP) of June 16, 1993, we are performing a programmatic review of environmental qualification (EQ) for electrical equipment. Our efforts in this regard are specifically defined under Action Item 3 of the EQ-TAP, which includes the following elements:

- 3.a Review License Renewal Background Information
- 3.b Review Fire Protection Reassessment Report
- 3.c Elicit Opinions from Others (Regions, EQ Experts)
- 3.d Review Existing EQ Program Requirements
- 3.e Review NRC Audit and Inspection Practices
- 3.f Review Licensee Implementation Practices
- 3.g Finalize Review Results

This particular evaluation is intended to address EQ-TAP action item 3.e, "Review NRC Audit and Inspection Practices." The specific objective of this review is to identify potential programmatic EQ issues and concerns by reviewing the audits and inspections of licensee and vendor EQ programs and subsequent enforcement taken as a result of those inspections after the implementation of the EQ rule. This is not intended to be a comprehensive review of all inspection and enforcement actions, but rather a review of a sample of reports and background information to identify any significant programmatic issues and concerns that pertain to the staff's practices regarding EQ.

Ultimately, all of the issues and concerns that are identified during the EQ programmatic review will be consolidated and discussed in the final report (EQ-TAP Action Item 3.g). Therefore, this evaluation does not include specific recommendations for further staff actions.

2.0 BACKGROUND

The criteria used in the NRC safety review process for all nuclear power plants (NPPs) includes the requirement that safety-related electrical equipment must be qualified to function in harsh environments that might occur as a result of design basis accidents. Although qualification standards and regulatory requirements have undergone significant development, all currently operating plants are required to comply with 10 CFR 50.49, "Environment Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," which ensures that structures, systems and components important to

safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.

In the late 1970s, concerns were raised about the capability of safety equipment to withstand harsh environments. In response to these concerns, the staff requested that plants participating in the Systematic Evaluation Program (SEP) submit documentation on their EQ programs. The staff's review of the submittals revealed that there were no significant deficiencies with the licensee's programs that required immediate remedial action, but that there were deficiencies that needed to be addressed. To address these deficiencies, the staff developed and distributed the Division of Operating Reactors (DOR) Guidelines, a document used by the staff as a screening criteria for reviewing operating plants' EQ programs, and issued NRC Bulletin 79-01B requiring that all licensees assess the adequacy of their EQ programs.

In May 1980, the Commission issued Memorandum and Order CL1-80-21 which established a schedule for the staff to issue safety evaluation reports (SER) for each operating plant assessing the licensee's compliance with 10 CFR 50 Appendix A, General Design Criteria (GDC) 4, "Environmental and Dynamic Defects Design Basis." The Order also stated that the DOR Guidelines and portions of NUREG-0588, "Interim Staff Position on EQ of Safety Related Electrical Equipment," form the EQ requirements that licensees must meet to satisfy GDC 4. The Order proposed that rulemaking be used to provide a permanent interpretation of GDC 4.

The NRC had concerns regarding inadequate responses to Bulletin 79-01B and issued several Orders and Bulletins to clarify their position. By mid-1981, the staff completed their review of licensee responses to IEB 79-01B and CL1-80-21, but were unable to make a thorough assessment of the EQ programs because the licensee submittals lacked sufficient detail. The NRC SERs from this review required licensees to make a more comprehensive submittal of their EQ programs. The NRC held extensive meetings with the nuclear industry to address industry concerns and questions regarding qualification and to provide detailed information about the format and content of the SER responses.

In 1981, the NRC authorized Franklin Research Center (FRC) to evaluate licensee resolution of issues from the staff's SERs, and to prepare technical evaluation reports (TERs) for each operating plant. The EQ program deficiencies identified in the FRC TER were conveyed to the licensee in an NRC SER for resolution. Once the deficiencies at each facility were addressed to the satisfaction of the staff, the staff issued a final SER to the licensee documenting the acceptability of their EQ program.

Similar to the review that was performed for operating reactors, the NRC also reviewed the EQ programs that were being developed by license applicants. To promote a more orderly and systematic implementation of the EQ requirements, NUREG-0588, IEB 79-01B and its supplements, and other regulatory documents were sent to the license applicants for consideration when developing their EQ programs. License applicants provided EQ program information through Section 3.11 of their Preliminary Safety Analysis Report (PSAR) and through other clarifying correspondence. The staff reviewed the submittals for completeness

and acceptability of the systems and components, qualification methods, and accident environments. The staff conducted on-site audits of each applicant's EQ program to verify that the applicant had established a program that was in accordance with their submittal. Section 3.11 of NUREG-0800, "Standard Review Plan," Revision 2, and NUREG-0588 formed the basis for the overall evaluation of the EQ programs that were being established by the license applicants.

The proposed final rule on environmental qualification of electrical equipment was published in the Federal Register in January 1982, and became effective in February 1983. This rule, Section 50.49 of 10 CFR Part 50, specified the requirements to be met for demonstrating the environmental qualification of electrical equipment important to safety located in harsh environments. The rule stated, in part, that each licensee must identify all equipment within the scope of the rule and submit a schedule for its qualification. The rule also stated that all EQ components under the scope of the rule had to be fully qualified no later than November 30, 1985.

The staff began conducting compliance inspections of EQ programs in 1985 to verify that licensees had implemented a program meeting the requirements of 10 CFR 50.49, and to follow-up on open items from the FRC TERs, license applicants' on-site audits, and SERs issued by the staff. Each operating power plant participated in the compliance inspections. The staff issued Temporary Instruction (TI) 2515/76, "Evaluation of Licensee's Program for Qualification of Electrical Equipment Located in Harsh Environments," as guidance for inspectors conducting EQ inspections at NPPs.

A more detailed summary of the development of EQ review and inspection practices is provided in Appendix A. Summary information is also provided about inspection practices at vendors providing EQ equipment and services to the nuclear industry, and about NRC enforcement practices associated with the EQ inspections.

3.0 EVALUATION OF EQ PROGRAM REVIEW AND INSPECTION PRACTICES

The objective of this section is to identify potential programmatic issues and concerns in the staff's review and inspection practices regarding EQ. To accomplish this objective, the staff: 1) reviewed the methodology used to evaluate license applicant, licensee, and vendor EQ programs, and 2) reviewed the results of several EQ program reviews, including TERs, SERs, and inspection reports for operating reactors; audit reports, SERs, and inspection reports for license applicants; and inspection reports for vendors.

3.1 Evaluation of EQ Program Review and Inspection Methodologies

Franklin Research Center's Technical Evaluation Reports (Operating Plants) - The staff reviewed the method used by FRC to evaluate EQ program information submitted by licensee in response to NRC SERs. A summary of the scope and methodology used by FRC to review the EQ programs of licensed plants during the period 1980-1982 is presented in Appendix B. Overall, FRC performed a comprehensive review of the information submitted by licensees in response to NRC Bulletins and Orders regarding EQ. However, the following programmatic

issues regarding the methodology used by FRC to conduct the program evaluations were identified:

- The scope of the evaluation did not include mild environment equipment, cold shutdown equipment, seismic and dynamic qualification, protection against natural phenomenon, operational service conditions (e.g., vibration), outdoor environments, protection against fire hazards, and protection against missiles.
- The scope of the TER did not provide for an evaluation of the acceptability of the licensee's stated service conditions for values and profiles.

While the TERs did not address the completeness of the master equipment list, this was addressed by the staff during subsequent EQ inspections (see below).

MRC Safety Evaluation Reports (Operating Plants) - The staff reviewed the method used by the MRC to ensure the EQ programs at plants licensed to operate met the requirements of 10 CFR 50.49. A summary of this methodology is presented in Appendix C. No issues or concerns were identified regarding the SER process used by the staff to review the licensee EQ programs.

MRC Safety Evaluation Reports (License Applicants) - The staff reviewed the method used by the MRC to review EQ programs at license applicants to ensure license applicants met the requirements of 10 CFR 50.49. A summary of this methodology is presented in Appendix D. The staff followed the guidance in NUREG-0800, "Standard Review Plan," for reviewing license applications. Because these facilities did not possess an operating license at the time of the review, and thus did not present an operational safety concern, the methodology used to review the applicant's EQ program was slightly different from the review conducted by the staff for operating plants. The staff's review of license applicant EQ programs included on-site audits (conducted by the staff and contractors) which were comparable in scope to FRC's review of operating plants. A summary of the on-site audit process is also presented in Appendix D.

The staff identified the following issues and concerns relative to the staff's review process for license applicant's:

- The documentation seems to indicate that the reviews of license applicant EQ programs were not as comprehensive as the technical evaluations performed by FRC and the staff for operating plants.
- Section 3.11 of NUREG-0800 was last revised in 1987 and is badly outdated. This document is still used to review EQ programs for new applicants.

MRC EQ Program Inspections (Operating Plant and License Applicant) - The staff reviewed the method used by the MRC to conduct EQ inspections at operating plants and license applicants (for post-licensing compliance inspections). A summary of the methodology is provided in Appendix E. All licensee EQ

programs have been inspected and accepted by the staff per the general guidance of TI 2515/76.

The staff found TI 2515/76 to be a comprehensive guidance document for reviewing EQ programs at operating facilities. The TI provided specific instructions and criteria for the selection of equipment to be reviewed, for the inspection of procedural and programmatic documents, and for the inspection of EQ documentation files. The TI also provided a series of checklists for use during the review of documentation files and for the physical inspection of EQ equipment (i.e., system walkdowns). The checklists were detailed, comprehensive, flexible (i.e., able to be used with different qualification requirements), and added consistency to the inspector's review of EQ equipment. A copy of the TI is provided in Appendix F.

However, the staff noted some problems with the use of TI 2515/76 for both operating reactors and license applicants:

- TI 2515/76 was issued March 27, 1986, and expired one year later. Licensee inspections prior to the issue date used a draft version of the TI and were conducted in a consistent manner with those inspections conducted after the TI was issued (See Appendix F, Nine Mile Point 1 for an example of an inspection conducted prior to March 1986). Even though the TI 2515/76 expired in March 1987, the staff continues to use the TI to perform EQ inspections and as a guide to perform pre-licensing audits of license applicant EQ programs.
- TI 2515/76 specifies that several EQ experts are needed to properly conduct an EQ program inspection. While many of these specialists can be provided through contracting, the staff must have employees trained in EQ to act as team leaders and team members. EQ training is unique and is not normally acquired during "on-the-job" training. There is no information in the TI about what level of expertise inspectors must have to conduct EQ inspections, only that they be "knowledgeable" in electrical equipment qualification. Most of the staff inspectors who participated in the EQ program inspections from 1986 to the present are not available to assist less experienced inspectors develop expertise. During the EQ program inspections (1985-1987), the staff conducted three-day EQ training seminars to educate inspectors and consultants on the specifics of EQ inspections. However, when the bulk of the EQ program inspections were complete, the NRC stopped offering this comprehensive training on EQ. Currently, no formal training is offered to educate the staff on environmental qualification practices and issues.
- Currently, there is no program in place to periodically perform inspections of licensee EQ programs that have already been accepted by the staff. EQ inspections are conducted reactively, usually as the result of a problem identified by the licensee or following the failure of a qualified component.

3.2 Evaluation of EQ Program Review and Inspection Findings

To determine whether EQ program review and inspection practices were thorough and consistently applied by the staff and its contractors, ten EQ program evaluations were examined (See Table 1). Inspection reports and inspection support documents, such as FRC TERs and the staff's SER, were included in the material examined for this review. Appendix G summarizes the findings from the TERs, SERs, and inspection reports that were included in this evaluation.

Table 1

EQ PROGRAM REVIEW DOCUMENTATION PRESENTED IN APPENDIX G					
PLANT	QUAL ¹	STATUS ¹	PLANT	QUAL	STATUS
Kewaunee	DOR	Oper	Palisades	DOR	Oper
Nine Mile Point 1	DOR	Oper	Turkey Point 3/4	DOR	Oper
Monticello	DOR	Oper	Peach Bottom 2/3	DOR	Oper
St. Lucie 1	DOR	Oper	North Anna 1/2	DOR & Cat II	Oper
Waterford 3	Cat II	Lic App	St. Lucie 2	Cat I	Lic App

¹ Plant EQ Requirements - Division of Operating Reactor Guidelines (DOR), NUREG-0588 Category II (Cat II) or Category I (Cat I)

¹ Plant Status - License status of the plant at the time the EQ rule was developed (Operating or license applicant)

Operating Plants

The staff compared the findings from the FRC TERs for eight operating plants to the deviations presented in the staff SERs to ensure that the issues and concerns identified during the program review were addressed by the licensee. Because of the tremendous number of deviations identified by the staff and FRC during this process, it was not feasible for the staff to document the specific resolution of each issue in an SER. Instead, the staff held meetings with the licensee and reached an understanding as to how the unresolved issues would be addressed before agreeing to accept the program. Because the specific issues and resolutions were not documented, it is not clear whether they were addressed consistently from plant to plant.

The staff's "final SER" accepting the program generally recognized the resolution of the program deficiencies, and specifically listed any program deviations that were still outstanding and had to be addressed by the licensee with a "justification for continued operation." Any open items and outstanding issues identified in the FRC TER or staff SER were addressed by the NRC inspection team during the on-site EQ program inspections. The scope and depth of the inspections were compared to guidance provided in TI 2515/76 and found to be satisfactory and consistent across the eight sample plants.

The staff also compared the scope and depth of the review process for each of the eight operating reactors selected for this sample. The staff considered several variables when comparing the practices and findings from this sample of program reviews, such as when the inspection was conducted, who performed the inspection, what NRC Region the licensee was located in, and other factors that may have affected the consistent implementation of inspection practices. Even though the specific findings differed from plant to plant, the process used to evaluate the plants appeared to be consistently applied at each plant.

In summary, after reviewing the EQ program evaluation details for eight operating plants, the staff concluded that the EQ program evaluations for operating reactors were completed in a consistent and comprehensive manner. However, because of the lack of documentation, it is not clear whether the staff addressed the resolution of specific program deficiencies consistently from plant to plant.

License Applicants

The staff reviewed EQ evaluations of two license applicants (Waterford 3 and St. Lucie 2) and the findings are summarized in Appendix G. The staff verified that issues and concerns identified in the pre-audit review of the applicant's program, during the on-site audit, and during the staff SER process were communicated to the license applicant and addressed to the satisfaction of the staff before the final SER accepting the program was issued. The staff found that the methodology used to review a license applicant's EQ program (see Appendix D) was applied consistently, based on the findings from the two license applicant reviews summarized in Appendix G. The staff noted that there were significantly fewer deficiencies identified by the contractor during these reviews and deficiency classifications varied from those used during the operating plant reviews. However, as in the case with the operating plant review process, issues and concerns identified during the pre-audit review were resolved or addressed by the staff prior to the applicant receiving an operating license. Even though there were significantly fewer deficiencies identified during the license applicant reviews, the number of deficiencies identified still made it unfeasible for the staff to document each deficiency and resolution in an SER. Deficiencies were individually resolved during a meeting with the licensee and generally referenced in an SER. Therefore, documentation about how the staff resolved individual deficiencies was not available for this review.

Compliance inspections were also conducted at each license applicant's facility after they received an operating license. The staff followed the methodology presented in Appendix E to conduct the inspections, which was similar to the methodology described above for operating reactors. Based on the inspection reports, the inspections appeared to be comprehensive and comparable in scope and depth to those conducted at the "operating plants" described above.

3.3 Evaluation of Inspection Practices and Findings from Vendor Inspections

The staff reviewed NRC inspection practices for nuclear industry vendors to identify any potential programmatic issues or concerns. Appendix H summarizes the staff's review of the methodology used to evaluate vendor programs and includes a summary of the findings from a sample of vendor inspections. The staff determined the scope and depth of the inspections by reviewing inspection reports and discussing the process with staff who were involved in the inspections.

In general, the vendor inspection reports were consistent with the scope of the inspection program. Documentation from the inspections revealed a consistent approach to inspecting EQ testing programs against the requirements of 10 CFR Part 50, Appendix B, and Part 21. Methodologies used to evaluate test plans and practices were consistent in scope and depth from facility to facility. However, the following programmatic concerns were identified during this review:

- There is currently no program to inspect EQ testing facilities or vendors. All inspections are done on a reactive basis.
- The systematic review of all EQ testing facilities was completed in 1986. EQ testing facilities that began operations after 1986 have not been inspected by the staff to ensure that their programs and facilities meet NRC requirements.
- No NRC inspection document was developed to provide consistent guidance and direction to the inspectors performing EQ inspections at vendor facilities. General guidelines for conducting QA and Part 21 inspections were available to provide consistency and scope for these inspections, and the IEEE standards and NUREG-0588 were used by the staff to form the technical basis for inspecting the vendor's EQ testing practices, but no programmatic inspection guidance was ever issued to ensure the inspections were consistent in scope and depth.

4.0 EVALUATION OF ENFORCEMENT PRACTICES AND FINDINGS

The objective of this section of the staff's evaluation is to identify potential programmatic issues and concerns in the staff's implementation of enforcement practices regarding EQ. To accomplish this objective, the staff reviewed a sample of the enforcement actions (i.e., Notices of Violation) that were taken as a result of the NRC EQ program inspections, or as a result of a reactive inspection involving EQ. A list of the plants that were sampled and a summary of the enforcement actions that were taken are summarized in Appendix H.

The staff examined the Notices of Violation and supporting documents for each sample plant, and compared the NRC's application of the enforcement policy at the time to the enforcement actions that were taken. The level of enforcement was compared among the different licensees to check for consistency, and the staff compared the enforcement actions taken with the guidelines in effect at the time to ensure that they were being implemented in an appropriate manner. The staff made the following observations regarding EQ enforcement actions that were taken:

- In general, enforcement actions that were taken by the staff were appropriate and supported by the documentation in the inspection reports. The staff followed the guidance in GLs 86-15 and 88-07, as appropriate. The nuclear industry claim that GL 86-15 was not prescriptive enough and thus would result in the staff issuing excessive civil penalties that were not consistent with the safety significance of the issue was not evident in the enforcement actions that were reviewed.
- The staff identified some apparent inconsistencies in the implementation of the NRC's enforcement policy for EQ (from GL 88-07) given the relative similarity of the deviations found during some of the inspections.

For example:

(1) At Farley, the staff sought a \$450,000 civil penalty for unqualified configurations (electrical splices and connectors) found on numerous components and several examples of EQ documentation that did not support qualification. At Indian Point 3, thirty-seven components were found in unqualified configurations and the similarity analysis that was used to qualify the hydrogen recombiners was deficient, but the staff only sought a civil penalty of \$75,000.

(2) Some deviations from 10 CFR 50.49, such as omitting EQ equipment from the Master Equipment List (MEL) or installing equipment in a configuration that did not demonstrate qualification, were not consistently categorized. Safety equipment accidentally left off the MEL was a Level V violation at Brunswick, a Level IV at Indian Point 3, and was included in the basis for escalated enforcement and issuance of a civil penalty for H.B. Robinson. While many factors are considered before enforcement action is taken, including the licensee's most recent performance, it is expected that similar inspection findings would result in similar enforcement actions, per se.

5.0 SUMMARY OF CONCERNS AND POTENTIAL PROBLEMS

The staff's evaluation of the NRC's review and inspection practices pertaining to EQ identified several potential issues for further consideration within the overall context of the EQ Task Action Plan. The issues have been summarized into the following two categories: (a) Review and Inspection Practices - Methodology, and (b) Enforcement Practices.

Review and Inspection Practices - Methodology

- The scope of the technical evaluation performed by Franklin Research Center (FRC-TER) did not include mild environment equipment, cold shutdown equipment, seismic and dynamic qualification, protection against natural phenomenon, operational service condition (e.g., vibration), outdoor environments, protection against fire hazards, and protection against missiles.

- The scope of the FRC-TER did not include an evaluation of the acceptability of the licensee's stated service conditions for values and profiles.
- The documentation that was reviewed indicates that the audit of license applicants by the staff and INEL may not have been as comprehensive as the technical evaluations that were performed by the staff and FRC for operating plants.
- The NUREG-0800 Section 3.11, used to review an applicant's EQ program, was last revised in 1987 and is badly outdated.
- The staff continues to use TI 2515/76 even though the document is out of date and was not designed to be used for license applicants.
- The NRC no longer provides training or practical experience in the area of EQ that would prepare the staff to address EQ problems at nuclear power plants.
- Currently, there is no program in place to periodically inspect licensee EQ programs that have already been accepted by the staff.
- Due to a lack of documentation in their SERs, it is not clear whether the staff addressed the resolution of specific EQ program deficiencies consistently from plant to plant (for operating plant reviews as well as license applicants).
- There is currently no program to inspect EQ testing facilities or vendors. All inspections are done on a reactive basis.
- The systematic review of all EQ testing laboratories was completed in 1986. EQ testing facilities that began operations after the systematic review ended have not been inspected by the staff to ensure that their facilities meet NRC requirements. Also, the staff has no plans to periodically revisit the facilities that participated in the original round of testing.
- No NRC programmatic document was developed to provide consistent guidance and direction to the inspectors performing vendor inspections.

Enforcement Practices

- A review of similar violations revealed an inconsistent application of enforcement actions taken by the staff, possibly indicating a need to clarify the staff's enforcement policy on EQ.

Principle Contributor: C. Gratton

Development of NRC Review and Inspection Practices

1.0 INTRODUCTION

The criteria used in the NRC safety review process for all nuclear power plants (NPPs) includes the requirement that safety-related electrical equipment must be qualified to function in harsh environments that might occur as a result of design basis accidents. Although qualification standards and regulatory requirements have undergone significant development, all currently operating plants are required to comply with 10 CFR 50.49, "Environment Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," which ensures that structures, systems and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.

In the late 1970s, as concerns were raised about the capability of safety equipment to withstand harsh environments, the staff developed two methodologies to review EQ programs and practices at nuclear power plants: one to review the EQ programs of operating plants, and the other to review the EQ programs of license applicants. Also, concurrent with the effort to review EQ programs associated with power reactors, the staff reviewed the practices of vendors supplying goods and services to the nuclear industry. These vendors are subject to inspection of their operations under the quality assurance requirements of 10 CFR Part 50 Appendix B and the requirements of 10 CFR Part 21 for reporting defects and noncompliances. The staff also formed a group of inspectors to review the EQ testing programs of those vendors performing EQ qualification testing.

To better understand and evaluate the NRC's practices for reviewing and inspecting licensee EQ programs, background information regarding the staff's practices is presented in the following sections.

2.0 EQ PROGRAM REVIEW PRACTICES

Operating Plants

In 1977, the NRC staff instituted the Systematic Evaluation Program (SEP) to determine the degree to which older operating NPPs deviated from the current licensing criteria. Electrical equipment qualification was selected for accelerated evaluation as part of this program. Late in 1977, the staff requested that all SEP plant licensees initiate reviews to determine the adequacy of their existing EQ documentation. Preliminary NRC review of the SEP plant EQ programs led to the preparation of NUREG-0458, "Short Term Safety Assessment on the Environmental Qualification of Safety-Related Electrical Equipment of SEP Operating Plants," which was an interim assessment of the status of SEP plant electrical equipment EQ. Even though the review concluded that "no significant safety deficiencies requiring immediate remedial action were identified," the staff recommended that additional resources be expended to examine EQ documentation and installation configuration of safety-related

electrical equipment in harsh environments for all operating NPPs. The staff's review of SEP plant EQ programs also indicated that additional deficiencies may exist related to: 1) the scope of the equipment addressed, 2) the definition of harsh environments, and 3) the adequacy of supporting documentation. To address these deficiencies, the staff developed the Division of Operating Reactors (DOR) guidelines for electrical equipment EQ, which was intended to be used as a screening criteria for reviewing all operating plant EQ programs, including SEP plant EQ programs.

Concurrent with the SEP review program, in 1979 the NRC Office of Inspection and Enforcement (IE) issued IE Bulletin (IEB) 79-01, "Environmental Qualification of Class IE Equipment," to all licensees of operating plants (except those included in the Systematic Evaluation Program). This bulletin, along with previously issued IE Circular 78-08, "Environmental Qualification of Safety-Related Electrical Equipment at Nuclear Power Plants," required licensees to assess the adequacy of their EQ programs. SEP plants were excluded from IEB 79-01 because they had already performed program assessments and documentation reviews as part of their participation in the SEP program (SEP Topic III-12, Electrical Equipment Qualification). The staff's review of licensee responses to IEB 79-01 indicated that certain deficiencies also existed relative to the more recently licensed (non-SEP) operating plants and that the generic criteria developed for SEP plants should also be applicable to non-SEP plants.

On January 14, 1980, the NRC issued IEB 79-01B, which included those criteria embodied in the DOR Guidelines and NUREG-0588, "Interim Staff Position on EQ of Safety Related Electrical Equipment," and required licensees to provide additional EQ information on safety-related electrical equipment. The DOR Guidelines were to be used as the criteria to evaluate the adequacy of equipment qualification, with NUREG-0588 used as a guide in instances where the DOR Guidelines did not provide sufficient detail. It was originally intended that licensees would evaluate their qualification documentation in accordance with the DOR Guidelines. However, initial NRC review of this documentation, which was gathered to support licensee submittals, revealed the need for obtaining independent evaluations and for accelerating the SEP plant equipment qualification review program.

In February 1980, the staff and representatives of the SEP Plant Owners Group held an open meeting to discuss the accelerated review of SEP plant EQ programs in accordance with the DOR guidelines. At this meeting, the staff gave the SEP representatives the DOR guidelines and a second document, "Guidelines for Identification of That Safety Equipment of SEP Operating Reactors for Which Environmental Qualification Is To Be Addressed." The staff requested that the SEP plant owners review their EQ programs and provide additional information to the staff on an accelerated schedule.

Subsequently, on May 23, 1980, Commission Memorandum and Order CLI-80-21 was issued which stated that the DOR Guidelines and portions of NUREG-0588 form the EQ requirements that licensees must meet in order to satisfy 10 CFR 50, Appendix A, General Design Criteria (GDC) 4. In the Order, the Commission established a schedule whereby the staff was required to issue safety evaluation reports (SERs) for each operating plant, including SEP plants,

assessing the licensee's compliance with GDC 4. The staff was to issue these SERs by February 1981, and licensees were required to complete all actions necessary to come into full compliance with the Order by June 1982. The Order also proposed that rulemaking be used to provide a permanent interpretation of GDC 4. Supplements to IEB 79-01B were issued for further clarification and definition of the staff's position in February, September, and October of 1980. The staff held regional meetings with licensees in mid-1980 to discuss the Commission's position regarding the EQ submittals required by CLI-80-21 and IEB 79-01B.

Due to NRC concerns regarding inadequate responses to IEB 79-01B, the Commission issued another Order in August 1980, requiring that licensees comply with CLI-80-21 to provide the necessary information by November 1980. The Commission also issued an Order in October 1980 requiring each licensee to establish a central file by December 1980 for maintaining all equipment qualification records.

By mid-1981, the staff completed their review of licensee responses to IEB 79-01B and CLI-80-21 (including the SEP plants) and issued SERs to most licensees. With few exceptions, the staff was unable to complete a thorough assessment because licensee EQ submittals were incomplete or lacked sufficient detail. The SERs highlighted program deficiencies and provided guidance on how the deficiencies should be addressed. Licensees were directed to submit their responses within 90 days of receipt of the SERs and to facilitate this effort, the staff held extensive meetings with the nuclear industry to address industry concerns and questions regarding qualification. The staff also provided licensees with detailed information about the format and expected content of the SER responses during these meetings.

In late 1981, the staff authorized Franklin Research Center (FRC) to evaluate licensee resolution of outstanding issues related to EQ discussed in the staff's SERs and to prepare a technical evaluation report (TER) for each of the operating plants. The objective of this evaluation was to: 1) identify all cases where the licensee submittals did not resolve the significant safety issues, 2) determine which equipment had adequate documentation and which did not based on established criteria, and 3) evaluate the adequacy of qualification documentation for equipment located in harsh environments that was required to be installed by NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident." FRC issued a TER for each licensee based on a review of the licensee's EQ program.

These TERs ultimately became the basis for the staff's safety evaluation for each licensee's EQ program. The deficiencies identified in the TER were reviewed by the staff and included in an SER to the licensee, with the TER included as an attachment to the SER. The staff met with each licensee to address the licensee's EQ program deficiencies. Once the EQ program deficiencies were addressed to the satisfaction of the staff and acceptable schedules were established for resolving the issues, the staff would issue a final SER documenting the acceptability of the licensee's EQ program.

The proposed final rule on environmental qualification of electrical equipment was published in the Federal Register in January 1982. This rule, Section

50.49 of 10 CFR Part 50, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," specified the requirements to be met for demonstrating the environmental qualification of electrical equipment important to safety located in harsh environments. The rule stated, in part, that each licensee must identify all equipment within the scope of the rule and submit a schedule for its qualification. The rule became effective in February 1983. The rule stated that all EQ components under the scope of the rule had to be fully qualified no later than November 30, 1985.

License Applicants

Similar to the review that was performed relative to operating reactors (discussed above), the NRC staff also reviewed the EQ programs that were being established by license applicants. Commission Order CLI-80-21 imposed the requirements of NUREG-0588 on the license applicants and in order to promote a more orderly and systematic implementation of these requirements, NUREG-0588 was sent to all license applicants in December 1979. Other applicable regulatory documents, such as IEB 79-01B and its supplements, were also sent to the license applicants for consideration in developing their EQ programs.

License applicants provided qualification program information to the staff, typically through Section 3.11 of their Preliminary Safety Analysis Report (PSAR) and through other clarifying correspondence. The staff reviewed these submittals for completeness and acceptability of the systems and components, qualification methods, and accident environments. Section 3.11 of NUREG-0800, "Standard Review Plan," Rev. 2 (1981), and NUREG-0588 formed the basis for the overall evaluation of the EQ programs that were being established by license applicants.

Included in the staff's review was the on-site audit of the applicant's EQ program. With the assistance of the Idaho National Engineering Laboratory (INEL), the staff performed a review of the applicant's EQ program similar in scope to the reviews that were performed by FRC of operating reactors. Prior to issuing the final SER accepting the program, the staff would conduct the on-site audit to verify that the applicant had established a program that was in accordance with his submittal. The on-site audit was not considered a compliance inspection because the applicant typically did not have the entire EQ program in place at the time of the audit, and the program had not been formally reviewed and accepted by the staff. The audit team would review a small sample of EQ equipment files (typically 10) and perform a walkdown of the components contained in those files to ensure the EQ program was being implemented per the stated requirements. INEL would prepare a report of the issues and concerns identified during the pre-audit review of the program material and the on-site audit of the applicant's program. These issues and concerns were conveyed to the applicant and rectified prior to issuing the operating license, unless a justification for interim operation was agreed to by the staff.

3.0 EQ PROGRAM INSPECTION PRACTICES

Nuclear Power Plants

Starting in 1985, to verify that licensees had implemented a program meeting the requirements of 10 CFR 50.49, and to follow-up on open items from the TERs that were issued by FRC, applicants' site audits, and unresolved issues documented in the SERs that were issued by the staff, the staff conducted compliance inspections at each facility.

The staff developed Temporary Instruction (TI) 2515/76, "Evaluation of Licensee's Program for Qualification of Electrical Equipment Located in Harsh Environments," as a guidance document for conducting the on-site inspections at those reactor sites that were operating during the development of the EQ rule. The staff also applied TI to those operating plants that did not have an operating license during the development of the EQ rule (i.e., the license applicants). The objectives of the EQ program inspections were to: 1) verify that EQ files contained the appropriate analyses and other necessary documentation to support the licensee's qualification conclusions, 2) ensure that maintenance and surveillance programs for qualified equipment were adequate to assure that this equipment was maintained in the as-analyzed or tested condition, and 3) verify the implementation of licensee commitments and actions that were described in written responses to the staff's SERs (and TERs) or during meetings with the staff. The first ten inspections were conducted on a team basis, with members of the headquarters staff (typically from the Vendor Inspection Branch) leading the inspections. Other team members included regional inspectors and consultants. All subsequent inspections were conducted by the Regional Offices, with support provided by headquarters inspectors and contractors.

Vendors

In addition to inspections of operating reactor and license applicant EQ programs, equipment and service vendors supplying products to the nuclear industry were also inspected by the staff's Vendor Inspection Branch during the early and mid-1980s. The objective of the vendor inspections, defined in Inspection and Enforcement Manual Chapter 2700, was to provide reasonable assurance that the products and services sold to licensees in the nuclear industry by non-licensee organizations met NRC regulations. The staff inspected vendor facilities to ensure that vendor programs met the quality assurance provisions of 10 CFR 50 Appendix B, as required under 10 CFR 50 Appendix B, Criterion IV. In addition, the inspections included a review of the vendor's 10 CFR Part 21 practices for dealing with component defects and nonconformances.

Under the vendor inspection program in the early 1980s, all of the nuclear steam system suppliers and architect engineering firms having active contracts in the nuclear industry were subject to regular inspections. Selection of vendors providing products and services for inspection by the staff and the frequency of the inspections were generally based upon the safety importance and the quality of the product or service being supplied, along with the vendor's performance history. It was the goal of the Vendor Inspection Branch

to inspect as many vendors as resources would allow during their two-year inspection cycle.

In 1981, the Vendor Inspection Branch formed a new Environmental Qualification Section to specifically address concerns surrounding the testing of environmentally qualified electrical equipment being supplied to the nuclear industry. Each supplier and laboratory performing EQ testing of electrical equipment covered by 10 CFR 50.49 was inspected over a three year period. The staff stopped performing these inspections in 1986 after all testing facilities had been inspected at least once.

4.0 EQ PROGRAM ENFORCEMENT PRACTICES

The deadline for compliance with 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," was specified in the rule as the date of the second refueling outage after March 31, 1982, or March 31, 1985, whichever was earlier. Some plants received deadline extensions to November 30, 1985.

In August 1985, the staff issued Generic Letter (GL) 85-15, "Information Relating to Compliance with 10 CFR 50.49," to remind licensees of the deadline for meeting the requirements of 10 CFR 50.49 and to inform them that extensions beyond the November 30, 1985 deadline would only be granted in rare circumstances. Licensees without extensions approved by the Commission that chose to operate with unqualified equipment beyond the deadline would be subject to enforcement actions. To emphasize the seriousness of being in non-compliance with the new EQ rule, GL 85-15 stated that licensees will pay civil penalties of \$5000 per day for each day of noncompliance after the deadline, for each unqualified equipment item. However, GL 85-15 did allow for some mitigation (or escalation) of the civil penalty, based on several factors:

- Had the licensee identified and promptly reported the noncompliance?
- Had the licensee applied best efforts to complete EQ within the deadline?
- Had the licensee proposed actions which could be expected to result in full compliance within a reasonable time?

Each of these factors could be used to mitigate or escalate the civil penalty. However, no clarifying instructions were given on how to implement this guidance at the time GL 85-15 was issued.

In September 1986, in response to questions raised by the nuclear industry, the staff issued GL 86-15, "Information Relating to Compliance with 10 CFR 50.49," to provide additional guidelines on appropriate licensee actions in situations where environmental qualification of equipment is suspect and on the current NRC policy on enforcing EQ.

The following guidelines were set for licensees who discovered a potential deficiency in EQ of equipment:

- Make a prompt determination of operability.

- Take immediate steps to establish a plan with a reasonable schedule to correct the problem.
- Have a written justification for continued operation (did not require NRC review or approval).

In addition, if the licensee was unable to demonstrate operability and the equipment was covered by plant technical specifications, the licensee was required to follow the appropriate action statements in the technical specifications. Otherwise, the licensee could continue operating using limited administrative controls to ensure the safety function was performed, or by ensuring that the equipment's safety function was accomplished by other designated equipment that was qualified.

GL 86-15 also included an enclosure with examples that clarified the application of the "Clearly Knew or Should Have Known" test¹, the time period to be considered for daily civil penalties, and how to apply the mitigating factors to determine the amount of the proposed penalty.

In April 1988, the staff issued GL 88-07, "Modified Enforcement Policy Relating to 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety." The EQ enforcement policy was revised because the Commission found that the policies established in GL 85-15 and GL 86-15 could result in penalties that did not reflect the safety significance of the violation, when compared with other non-EQ penalties that were being imposed. GL 88-07 superseded the policy established in GLs 85-15 and 86-15, and made five major changes to the EQ Enforcement Policy that had been established by GL 85-15: 1) it aggregated significant EQ violations rather than keeping them separate, 2) it assessed a base penalty according to the number of systems affected by the unqualified equipment, 3) it established a maximum fine of \$750,000, 4) it established a minimum fine of \$50,000 for significant EQ violations, and 5) it considered mitigation or escalation of the civil penalty based on several factors (e.g., identification and reporting, corrective actions, duration of the violation, etc.).

Included with GL 88-07 was an enclosure to provide details and examples on the modified policy for EQ enforcement. The enclosure was divided into four sections: (1) Scope, (2) Application of the "Clearly Knew, or Should Have Known" test for violations that existed before the November 30, 1985 deadline, (3) Violations Not Sufficiently Significant to Merit a Civil Penalty, and (4) Basis for Determining Civil Penalties.

Full mitigation was allowed for those licensees in violation of 10 CFR 50.49, who met all of the following five criteria:

- violations were isolated and affect limited systems/components,
- violations were identified by the licensee,
- violations were promptly reported,

¹ A test to determine whether the licensee knew or should have known they had equipment for which qualification could not be established by the deadline established in 10 CFR 50.49.

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- violations were corrected within a reasonable time period, and
- violations for which the licensee has demonstrated best efforts to complete EQ within the stated deadlines.

The decision to allow full mitigation for those violations meeting the five criteria above was deemed appropriate in order to remove the disincentive for licensees to report EQ violations found during their internal audit and inspection practices.

Technical Evaluation Reports Background, Scope, and Methodology

Technical Evaluation Report (TER) Development

In December 1977, nuclear power plants participating in the Systematic Evaluation Program (SEP) were requested to review their equipment qualification documentation to determine its adequacy. The resulting submittals were reviewed by Franklin Research Center (FRC) and a TER documenting the licensee's EQ deficiencies was prepared for each facility. The staff prepared a safety evaluation report (SER) to document the qualification documentation deficiencies and forwarded the SER and the TER to each licensee.

In 1980, all licensees of operating plants (except those participating in the SEP program) were required to examine their installed safety-related electrical equipment and ensure that sufficient qualification documentation existed to demonstrate that the equipment would function under postulated accident conditions. By mid-1981, the staff completed their review of the licensee submittals and issued SERs for each operating reactor. The SERs required each licensee to respond to the deficiencies identified within 90 days. FRC was again tasked with reviewing the licensee responses and preparing a TER for each facility. Even though the SEP plants had already made an initial submittal and undergone a review by FRC, the staff requested that they submit their EQ program information and included the SEP plants in this more comprehensive review. FRC reviewed the EQ information that was provided by the SEP plants and prepared TERs to document the results of their reviews. The final SEP-plant TERs were based on (1) the results of the initial TER, (2) the licensee's response to the staff SER accompanying the initial TER, and (3) the licensee's updated electrical equipment qualification (EEQ) submittal. The TERs for non-SEP plants were based on each licensee's updated EEQ submittals and response to the staff's SER.

The following paragraphs describe the scope and methodology used by FRC to develop the final TERs. Final TERs were issued for all operating plants, including those participating in the SEP program. The initial TERs for the SEP plants were limited reviews and their results were reflected in the final TERs for those plants.

Purpose and Scope

The purposes of the FRC review were to: 1) evaluate the licensee's resolutions of outstanding issues related to safety-related EQ equipment and identify where the licensee's responses did not resolve the significant qualification issues that were identified, 2) evaluate the licensee's documentation and determine which equipment had adequate EQ documentation and which did not, 3) evaluate the licensee's EQ documentation of equipment identified in NUREG-0737, "TMI Action Plan Implementation," and 4) determine whether the licensee proposed adequate corrective actions to resolve qualification

deficiencies and provide a schedule for the completion of the corrective actions.

The scope of the FRC review was limited to evaluating the qualification of equipment that must function to mitigate the consequences of a LOCA or HELB whose environment was affected by the event. The scope of the review also included equipment in NUREG-0737 but was limited to equipment having an installation date prior to January 1, 1981 (although equipment installed after January 1, 1981, was also reviewed in cases where adequate information was provided by the licensee).

The scope of the review did not include mild environment equipment or cold shutdown equipment. Technical data or test results that satisfied the qualification criteria were not discussed. Other aspects of qualification that were not included within the scope of the FRC review were:

- seismic and dynamic qualification
- protection against natural phenomenon
- operational service conditions (e.g., vibration)
- outdoor environments
- protection against fire hazards
- protection against missiles

In addition, the scope of each FRC review did not address: 1) the completeness of the licensee's master list, or 2) the acceptability of the licensee-stated service condition values and profiles. The completeness of each licensee's master list was, however, verified in later NRC-lead EQ program inspections.

Review Methodology

The relative completeness of each licensee submittal was reviewed by FRC using the following NRC-supplied bases:

- determine whether the licensee responded to the NRC concerns documented in the SER,
- determine whether the licensee proposed corrective actions for the deficiencies, including a schedule for completion,
- determine whether the licensee addressed the NRC's concern for margin for containment environmental conditions,
- determine whether the licensee revised the environmental parameters,
- determine whether the licensee's System Component Evaluation Worksheets were updated to correct deficiencies,
- determine whether the licensee provided justification for interim operation for all unqualified equipment, and
- determine whether the licensee addressed aging and incorporated the results into the equipment maintenance program.

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Each licensee analyzed its safety-related equipment and grouped it into "equipment items," or groups of identical equipment that were exposed to the same environmental service conditions. The FRC TERs included appendices that a) listed the environmental service conditions for each applicable plant location, b) contained the tabulation of the equipment items, locations, required operating times, function, plant ID numbers, and applicable qualification documentation references, and c) listed the plant systems identified by the licensee and the NRC as being essential to safety.

For each item on the equipment item list, FRC reviewed:

- the licensee's response to the NRC SER deficiencies,
- the technical information received from the licensee's submittal or as a result of requests for additional information,
- NRC DOR Guidelines and NUREG-0588 Rev. 1 criteria,
- the licensee's definition of harsh service environment,
- documentation cited by the licensee as evidence of qualification,
- applicable and available qualification documentation associated with the overall equipment environmental qualification program,
- the licensee's analysis and justification of qualification,
- licensee-proposed corrective actions for qualification deficiencies,
- the licensee's equipment and part replacement schedules,
- the licensee's technical arguments concerning the adequacy of equipment, based on system operational considerations, and
- the licensee's rationale concerning exemption of equipment from qualification.

FRC also included an evaluation of the equipment included in NUREG-0737. The objective of this review was to evaluate the qualification documentation of equipment within the scope of IEB 79-01B, Supplement 3, in a manner identical to all other safety-related equipment located in harsh environments. The scope of the review was limited to TMI Action Plan equipment associated with those sections of NUREG-0737 which had equipment installation dates prior to January 1, 1981.

To assist FRC in the review of each equipment item, FRC developed checksheets that contained the various screening criteria required by the NRC. The checksheets contained the following information:

- equipment item information (e.g., licensee ID number, location, etc.)
- qualification deficiencies identified in the NRC-SER

- the licensee's response to the NRC-SER
- licensee's statements and rationale for qualification
- licensee's corrective actions and replacement schedules
- evaluation of qualification including identification of all deficiencies
- evaluation of system considerations presented by the licensee as a rationale for excluding equipment from qualification

The results of each equipment item evaluation was summarized on a final checksheet, which identified any deficiencies and indicated which NRC-developed qualification category the equipment was assigned to.

The NRC provided FRC with "Qualification Categories" as part of the evaluation program. FRC was instructed to place each equipment item in one of the following categories, based on the evaluation of all available qualification information.

- Category I.A - Equipment that satisfies all applicable requirements of the DOR Guidelines or NUREG-0588, or the licensee has presented information to determine that deviations from the criteria are acceptable or insignificant. For example, Palisades ended their LOCA testing prior to the 30 days post-accident period. The licensee justified ending the test early (after 14 days) because the equipment was still functional after the test parameters returned to pre-accident levels 11 days into the post-accident period. FRC reviewed the licensee's justification and agreed.
- Category I.B - Equipment for which deviations from the DOR Guidelines or NUREG-0588 are judged conditionally acceptable provided that specific modifications are made. Examples of modifications include: replacing unqualified equipment with qualified equipment, modifying the equipment to meet the criteria, relocating the equipment to meet submergence requirements, etc.
- Category II.A - Equipment for which qualification documentation is insufficient to establish that the equipment is or is not qualified in accordance with the DOR Guidelines or NUREG-0588.
- Category II.B - Equipment that is unqualified.
- Category II.C - Equipment that satisfies all applicable requirements of the DOR Guidelines or NUREG-0588 with the exception of qualified life (for DOR equipment, component replacement schedules discussed in the guidelines were considered the qualified life).

- Category III.A - Equipment that is exempt from qualification (e.g., does not provide a safety function, some other fully qualified equipment that is single-failure-proof can provide the safety function).
- Category III.B - Equipment that is not in the scope of the qualification review (i.e., cold shutdown and mild environment equipment).
- Category IV - Equipment for which qualification documentation has not been made available for review.

In addition to providing the NRC with the list of equipment items falling into each of the above categories, FRC also grouped equipment items that were deficient in the following categories (an equipment item could belong to one or more of these groups). The criteria used to determine whether the documentation was deficient was contained in the applicable requirements document for that licensee (e.g., DOR Guidelines, NUREG-0588 Category II, etc) and augmented by the information provided by the staff in supplements to IE Bulletin 79-01B.

1. Documented evidence of inadequate qualification.
2. Adequate similarity between equipment and test specimen was not established.
3. Aging degradation was not adequately evaluated.
4. Qualified life or replacement schedule were not established
5. Program to identify aging degradation not established.
6. Criteria regarding aging simulation not met.
7. Criteria regarding temperature/pressure exposure (EQ testing) not met.
8. Criteria regarding spray not satisfied.
9. Criteria regarding submergence not satisfied.
10. Criteria regarding radiation not satisfied.
11. Criteria regarding test sequence not satisfied.
12. Criteria regarding analysis of test failures or severe anomalies not satisfied.
13. Criteria regarding functional testing not satisfied.
14. Criteria regarding instrument accuracy not satisfied.
15. Test duration margin not satisfied.
16. Criteria regarding margins not satisfied.

These deficiencies were reviewed by the staff and forwarded to the licensee with instructions to address each of the deficiencies that affected the qualification of the equipment items.

Safety Evaluation Reports for Operating Plants Scope and Methodology

After reviewing the Franklin Research Center (FRC) technical evaluation report (TER), the staff would document the findings in a Safety Evaluation Report (SER) and forward the SER and TER to the licensee. The licensee was given time to review the staff's SER and provide a formal response to the deficiencies that were identified. Subsequent licensee submittals were then reviewed by the staff and a final determination was made about the acceptability of the licensee's program.

Methodology

The staff's acceptance of the licensee's EQ program was based on the results of an audit performed by the staff of: 1) the licensee's proposed resolutions to deficiencies identified by the staff's SER, 2) the licensee's compliance with the requirements of 10 CFR 50.49, and 3) the licensee's justification for continued operation (JCO) for the equipment items for which qualification had not yet been established.

Licensees addressed each SER deficiency using one or more of the following:

- replacement of the deficient equipment item
- additional analysis
- additional qualification documentation not review by FRC
- reclassification of the equipment item such that the requirements of 10 CFR 50.49 did not apply

Deficiencies were typically discussed item-by-item during a meeting between the staff and the licensee until agreement was reached on the resolution of all deficiencies. Analysis and documentation deficiencies were not included in this review, but were followed-up during the subsequent site inspections by the staff.

To ensure the Master Equipment List (MEL) was complete and met the requirements of 10 CFR 50.49 sections (b)(1), (2), and (3), the staff completed the following reviews:

- For section (b)(1): safety-related electrical equipment

The staff reviewed the design basis events considered by the licensee when selecting safety-related equipment, the licensee's equipment selections based on the information given in 10 CFR 50.49(b)(1), and the Final Safety Analysis Report (FSAR), Technical Specifications, Emergency Operating Procedures (EOPs), piping and instrumentation diagrams, and other procedures and references.

- For section (b)(2): non-safety equipment whose failure under accident conditions could prevent the satisfactory accomplishment of a safety function

The staff reviewed the licensee's selection of non-safety equipment for this category to ensure that adjacent safety-related equipment was electrically isolated by properly coordinated protective relays, circuit breakers, or fuses. Operation of all support systems and equipment, including room ventilation and component cooling that were directly or indirectly connected to safety equipment, were reviewed.

- For section (b)(3): certain post-accident monitoring equipment

The staff reviewed the licensee's selection of equipment required by Regulatory Guide (RG) 1.97, "Instrumentation ... to Assess Plant and Environmental Conditions During and Following an Accident," to ensure that equipment located in harsh environments was on the MEL.

Finally, the staff reviewed all of the justifications for continued operation (JCOs) for deficiencies that were identified in the TER and not corrected by the time the submittal was made. The staff's acceptance of JCOs that were submitted was based on the following criteria:

- the safety function could be accomplished by other qualified equipment
- partial test data provided a basis to conclude that the equipment would perform its function
- limited use of administrative controls over equipment that was not demonstrated to be fully qualified was employed

For all of the criteria specified above, it was assumed that the failure of unqualified equipment that was addressed by the JCO would not impair the safety function of other safety-related equipment.

Safety Evaluation Reports for License Applicants Scope and Methodology

License applicants were required to submit EQ program information for review by the staff to ensure that their program met the requirements of 10 CFR 50.49. The staff's evaluation of the applicant's EQ program included an on-site examination of equipment, audits of qualification documentation, and a review of the applicant's submittals for completeness and acceptability of systems and components, qualification methods and accident environments. The staff used NUREG-800, "Standard Review Plan," Revision 2 (1981), Section 3.11, and NUREG-0588, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," Revision 1, to form the basis for their review.

NUREG-800 - Section 3.11, EQ of Mechanical and Electrical Equipment

Information necessary to support the conclusion that all items of equipment are capable of performing their design safety function under all normal, abnormal, and accident environmental conditions is provided by the applicant in Section 3.11 of the Preliminary Safety Analysis Report (PSAR). This information was reviewed by the staff to determine whether the required environmental capability of all equipment has been demonstrated.

At the time NUREG-0800, Revision 2, was developed, the environmental qualification requirements were embodied in General Design Criteria (GDC) 4 of Appendix A to 10 CFR 50. These requirements could further be generalized as follows: (1) each piece of qualified equipment shall be designed to perform its functions under all normal, abnormal, accident and post-accident environments for the length of time for which its function is required; (2) the equipment's environmental capability shall be demonstrated through appropriate test and analyses; and (3) a quality assurance program shall be in place that meets the requirements of 10 CFR 50 Appendix B. The environmental design of mechanical and electrical equipment was deemed acceptable if it could be ascertained that all three requirements were met.

For EQ equipment located in harsh environments, SRP 3.11 identifies the applicable IEEE standard or NRC Regulatory Guide to be used to evaluate the applicant's program. In most cases, the applicant was to provide documentation that addressed the effects of a qualified equipment's service conditions (including the effects of design basis accidents and HELBs inside and outside containment), submergence, chemical sprays, and radiation, if applicable. For components in mild environments, the reviewer was only required to ensure that the equipment would perform its function under normal and abnormal conditions and that it was supported by a maintenance and surveillance program and good preventative maintenance.

The staff had the opportunity to review the program at both the construction permit and the operating license application stages. At the construction permit stage, the staff measured the licensee's program against the

requirements described above, paying particular attention to the proper use of test and analytical procedures used to qualify the components. At the operating license stage, the staff performed a final review of the EQ program described in the applicant's Final Safety Analysis Report, which included an on-site audit (described below) of the licensee's equipment qualification documentation and a walkdown of safety-related systems and components.

From the final review, the staff generated a Safety Evaluation Report (SER) documenting the acceptability of the licensee's EQ program. If the staff identified any deficiencies, the licensee was required to resolve the deficiencies, or submit a justification for interim operation for review and approval by the staff, before the operating license would be issued.

Review of Applicant's EQ Program

The EQ program review was developed to evaluate an applicant's EQ program and was similar in scope to the Franklin Research Center's (FRC) technical evaluations that were completed for operating plant EQ programs. The review included an on-site audit which would typically be conducted in the latter phases of the construction program when the licensee had completed their EQ program and was implementing the program on those systems turned over for operations. According to the Idaho National Engineering Laboratory (INEL), NRC contractor for program audits, the scope of the review included an evaluation of the completeness of the Master Equipment List, the criteria which must be met, the environments in which equipment must function, and an assessment of the documentation for the equipment.

The program review consisted of three major parts:

- (1) An evaluation of the applicant's overall program prior to going to the site. This review would include a programmatic review of available procedures, and a technical review of the basis for each piece of equipment in the EQ program.
- (2) An on-site audit of the applicant's central files containing the EQ program's documentation. The applicant's central files were reviewed by a team of EQ specialists from the NRC staff and their consultants. The team would typically review a portion of the EQ files.
- (3) A visual inspection of the equipment items for which the central files were audited. During the visual inspection the team would consider those physical qualities important to environmental qualification, such as the component's location, orientation, and condition.

The observations and concerns identified during the program review were included in the response to the licensee's submittal. The staff separated the electrical equipment into three categories: (1) equipment requiring replacement prior to plant startup, (2) equipment requiring additional information or corrective action, and (3) equipment considered acceptable or conditionally acceptable, pending implementation of the maintenance and surveillance program. The staff did not necessarily consider equipment in category (2) unqualified, however additional information and analysis was

required before the staff would accept the equipment. For equipment in category (2), corrective actions or deficiencies were noted in the following areas:

- Material aging evaluation; replacement schedule; ongoing equipment surveillance.
- Chemical spray
- Exempted equipment justification inadequate
- Humidity
- HELB evaluation outside containment not completed
- Margin
- Pressure
- Qualification information being developed
- Qualification method
- Qualification time
- Radiation
- Equipment location or replacement schedule not provided
- Retest, schedule not provided
- Submergence
- Separate effects qualification justification inadequate
- Temperature
- Qualification criteria incorrect

The staff identified one concern during the evaluation of license applicant EQ program reviews:

- As part of the evaluation of inspection practices, the staff reviewed the findings from a total of ten program evaluations at operating plants and license applicants (See Appendix G). Comparing the findings of the operating plant TER reviews to the findings from license applicant program reviews performed by INEL, the staff observed significantly fewer findings (in aggregate) from the review of the applicant's program documentation. The number and type of deficiency categories used by INEL also varied from those chosen by FRC. Because INEL did not include information in their audit report about the methodology used to review the applicant's program, it is not clear whether the scope and depth of the INEL reviews were equivalent to the FRC reviews.

NRC EQ Site Inspections Objectives and Methodology

Prior to the implementation of the EQ rule for licensees, the Vendor Inspection Branch (VIB) conducted inspections of vendors who provided EQ products and services to the nuclear industry. It was the goal of the VIB at the time to inspect as many providers of EQ services as possible. As part of the new EQ rule, the VIB was tasked with developing and conducting a pilot program to inspect licensee EQ programs. The VIB developed inspection instructions (Temporary Instruction (TI) 2515/76, "Evaluation of Licensee's Program for Qualification of Electrical Equipment Located in Harsh Environments") and, using the EQ inspection experience gained from the inspection of EQ vendors, conducted training seminars for regional inspectors at Sandia National Laboratories (NL) before commencing the inspection program. Contractors from Sandia NL and Idaho National Engineering Laboratories (INEL) assisted with most of the EQ inspections.

Typically, an on-site inspection of the licensee's EQ program was performed after the staff 1) reviewed the EQ program submittal, 2) reviewed the Franklin Research Center (FRC) technical evaluation report (TER) for that licensee's EQ program, 3) performed a site audit of the licensee's "as implemented" EQ program, and 4) accepted the licensee's EQ program, including any corrective action plans or justifications for interim operations, and issued the final safety evaluation report (SER).

Objectives

The objective of TI 2515/76 was to provide guidance for the inspection of licensee environmental qualification programs for electrical equipment important to safety located in harsh environments as required by 10 CFR 50.49. The TI also ensured that licensee commitments for resolution of outstanding issues from the staff's SERs were being properly implemented.

During these inspections, the NRC: 1) reviewed the implementation of the licensee's EQ program, 2) reviewed the licensee's implementation of SER corrective action commitments, 3) reviewed the licensee implementation of a program for maintaining the qualified status of equipment during the life of the plant, and 4) performed a walk-down of equipment to verify that the installation conformed to the SER commitments and qualification requirements.

Site Inspection Methodology

The staff assembled an inspection team consisting of a team leader, a technical specialist (electrical and power control equipment), a quality assurance (QA) specialist (QA requirements for procurement, maintenance, and testing), and an EQ specialist (EQ testing, analysis, and documentation requirements). Prior to each inspection, the inspectors would review the following documents applicable to the site (at a minimum):

- The FRC Technical Evaluation Report (TER), as applicable.
- Previous SERs concerning EQ, including the SER that forwarded the FRC TER.
- The licensee's Master Equipment List (MEL)
- Generic Letter (GL) 84-24, "Certification of Compliance to 10 CFR 50.49," and the licensee's response to GL 84-24.
- EQ procedures

In addition to reviewing these documents, the inspection included an evaluation of the qualification documentation and physical inspection of 10-15 equipment items. The inspection team selected the equipment items based on criteria specified in TI 2515/76, which included:

- Deficient equipment items identified in the TER.
- Outstanding IE Bulletins and Information Notices related to EQ
- Accessibility of the equipment.
- Plant specific EQ-related Licensee Event Reports and problems reported under 10 CFR Part 21.
- Equipment added to or deleted from the MEL since the issuance of the TER.
- Equipment that changed TER categories since the TER was issued.
- Equipment that had no documentation submitted for the TER.
- Newly installed equipment that replaced unqualified equipment.
- At least one piece of DOR Guidelines equipment, as applicable.
- A variety of equipment types.
- Sensitivity of core damage to component failure.

The site inspection consisted of three parts: 1) a procedural and programmatic inspection, 2) a documentation file inspection, and 3) a physical inspection of equipment in-situ. Comprehensive checklists were developed for each part of the audit to promote consistency between inspectors and between inspections. Appendix F contains a copy of the TI including the site audit checklists.

During the procedural and programmatic review, the inspection team reviewed the licensee's procedures for generating and maintaining the MEL, reviewing and approving EQ documentation, and addressing IEBs and INs related to EQ. The team also reviewed procedures that implemented EQ maintenance and surveillance practices, procurement practices, and controlled plant modification practices with respect to EQ. The inspection team interviewed site personnel about their responsibilities regarding qualified equipment and reviewed QA/QC records for conformance to procedural requirements.

During the documentation file review, among other things, the inspection team reviewed the completeness of the licensee's MEL, evaluated whether program procedures regarding changes to the MEL were being followed, reviewed the qualification files of the equipment sample that was selected to ensure the qualification requirements were addressed, reviewed the documentation files to determine whether similarity was established between qualified devices and the tested equipment, determined whether commitments for corrective actions were fulfilled by the licensee, and examined the replacement equipment review and approval process.

During the physical inspection, the inspection team determined whether the installed equipment (equipment type, installation orientation and configuration requirements for qualification) was the same as described in the licensee's qualification documentation, and checked the equipment surrounding the qualified equipment to determine whether failure of the surrounding equipment could affect the ability of the qualified equipment to perform its required function.

TI 2515/76 was also used as guidance by the staff when inspecting the EQ programs of those plants licensed after the EQ rule became effective. The staff used portions of TI 2515/76 to develop the inspection plan for the post-licensing compliance inspection that was conducted at each facility. Because the TI was specifically developed to inspect EQ programs at facilities that were already operating when the EQ rule became effective, some of the reviews required by the TI were not applicable to newer plants. In general though, the TI provided an acceptable framework upon which the inspector could build an inspection plan.

The staff continues to use the TI as an aid in developing inspection plans for license applicants. The TI has not been revised since 1987 and contains guidance that is not applicable to reviewing EQ programs at license applicants.