

NRR/RES TEAM REPORT
DISPOSITION OF EQ PROGRAMMATIC REVIEW RECOMMENDATIONS

1.0 INTRODUCTION

In April 1996, NRR staff completed a programmatic review of NRC's EQ program and developed a draft summary report. This summary report contained specific recommendations for the enhancement of the overall NRC EQ program. In a memorandum dated September 18, 1998 addressed to the director of NRR, the director of RES stated that these recommendations must be evaluated and dispositioned in parallel with the resolution of GSI-168, "Environmental Qualification (EQ) of Electric Equipment". RES proposed the formation of a small intra-agency team to evaluate the recommendations and to document its findings on each recommendation. With NRR agreement, RES proceeded with the formation of the proposed team. Members are S.Aggarwal (RES), J.Vora (RES), J.Knox (NRR), and G.Hubbard (NRR).

The team's responses for each recommendation are presented in the following evaluation.

2.0 BACKGROUND

In SRM (SECY93-049) dated June 28, 1993, the Commission directed the staff to treat environmental qualification (EQ) of electric equipment as a potential safety issue within the regulatory process for operating reactors. On July 1, 1993, the staff responded by proposing the EQ Task Action Plan (EQ-TAP). The purpose of the EQ-TAP was to evaluate and resolve existing environmental qualification concerns and to identify and resolve any other EQ issue that may exist.

As part of EQ-TAP, a comprehensive programmatic review of NRC's EQ program was initiated to gain insight into the development and implementation of existing EQ requirements and to determine whether weaknesses identified in other similar NRC programs were evident in the EQ program. This review included an evaluation of the relevant recommendations from the Fire Protection Program Reassessment Report, a survey of NRC and industry EQ experts, a review of NRC EQ program requirements, a review of NRC EQ audit and inspection practices, and a review of the practices implemented by licensees with regard to 10 CFR 50.49 (EQ rule).

NRR staff completed a programmatic review of the NRC's EQ program and developed a draft summary report. This summary report contained specific recommendations for the enhancement of the overall NRC EQ program. The team's responses for each recommendation are noted in Section 3.

3.0 EVALUATION

RECOMMENDATION 1

It may be possible to address many of the potential issues that have been identified by reviewing and better understanding past research efforts and EQ information that has been developed over the years, and this approach should be pursued before considering other alternatives. Additional research should be performed only if: (a) there is a well defined need for additional information; (b) there is a good likelihood that the desired information will be obtained;

and (c) the cost is justified in terms of the expected benefits to public health and safety.

Response:

The team agreed with this recommendation. As part of the resolution of GSI-168¹, the NRC staff and its contractors conducted a comprehensive review of past research, qualification test reports, and other EQ related literature. The results of this review were presented in NUREG/CR-6384, "Literature Review of Environmental Qualification of Safety-Related Cables: Summary of Past Work," Volume 1, April 1996. In Volume 2 of this same report, these results were analyzed in relation to known potential EQ issues. From this effort, it was possible to address most of the EQ related technical issues without the need for additional actions..

The team also agreed with the recommendation for initiating additional research based on appropriate justification. In resolving GSI-168, the staff is currently following NRC administrative practices which necessitate the recommended justification for each research project prior to its implementation.

Also, see response to recommendation 2 below.

RECOMMENDATION 2

The NRC staff should review the results of past and ongoing EQ research efforts, qualification test results and practices, and other EQ information, and maintain an up-to-date data base containing this information in order to: (a) better manage, catalogue, and share EQ information and advances in technology; (b) identify specific issues that may deserve additional research and resolution; (c) provide a basis for resolving EQ concerns; and (d) better focus NRC staff and industry resources.

Response:

The team disagreed, in part, with this recommendation. It is not cost-effective for the NRC staff to maintain an up-to-date EQ data base on a continual basis. In addition, maintenance of an up-to-date EQ data base is not consistent with the NRC's oversight responsibility. The team felt that an up-to-date EQ data base should be maintained by the licensees and industry groups to address EQ issues.

The team, however, agreed with the recommendation that the NRC staff should review the results of past and ongoing EQ research efforts, qualification test reports, and practices, and other EQ literature. As indicated, in response to recommendation 1, the NRC has completed this recommended review. As part of this effort, an EQ database was developed. This database (with a users guide) was made available to the nuclear industry in two different

¹GSI-168, "Environmental Qualification for Electric Equipment" stems from the NRR's Task Action Plan. The EQ TAP was established to focus on three major issues: (i) differences in EQ requirements between newer and older plants; (ii) adequacy of accelerated aging practices; (iii) programmatic review of EQ requirements to identify and resolve any other EQ concerns .

software formats. This review (presented in NUREG/CR-6384, Volume 1) and the development of an EQ database accomplishes the recommendation's stated objective for better management, cataloguing, and sharing of EQ information and advances in technology. Analysis of Volume 1, as presented in Volume 2, accomplishes the recommendation's stated objective for (a) identification of specific issues that deserved additional research and resolution, (b) basis for resolving EQ concerns, and (c) better focus of NRC staff and industry resources. Meetings with industry (as described below in response to recommendation 3) further accomplishes the recommendation's stated objective for sharing of EQ information and advances in technology.

RECOMMENDATION 3

A functional interface between the NRC and industry should be established for addressing EQ issues and concerns in a cooperative and technically sound fashion. Since the existing interface with NEI tends to inhibit the exchange of information and ideas between industry experts and the NRC staff, NRC management should either resolve this problem or establish other avenues for industry participation. In support of this initiative, this final report on the EQ programmatic review, as well as the other reports that have been completed under EQ-TAP Action Item 3 [6-11], should be made available to the general public.

Response:

The team agreed with this recommendation. Over the past several years, the staff has interacted with the nuclear industry on a regular basis. The staff regularly participates in industry meetings with groups, such as NUGEQ, NUS, NEI, EPRI, ASME, IEEE, to exchange technical information concerning EQ issues and to discuss the status of the NRC Research Program. In addition, the staff has held EQ Workshops in November 1993 and July 1996 and several technical meetings to openly discuss the technical EQ issues and the NRC approach to resolve them. All EQ reports, including test plans, which were generated by the staff or its contractors have been made publically available.

The EQ programmatic review report completed under EQ-TAP Action Item 3g was made available to the general public in February 1999.

RECOMMENDATION 4

While it is important to alert the industry of potential generic problems with equipment qualification, NRC expectations of licensee actions should be communicated through issuance of Bulletins or Generic Letters. Information Notices should not be used as a vehicle for implicitly suggesting that licensees should take some sort of action.

Response:

The team agreed with this recommendation. This recommendation is consistent with current NRC administrative practice. The responsibility for correct use of generic communications, including no new requirements being implicitly suggested as part of Information Notices, is performed by the Events Assessment, Generic Communications and Non-Power Reactors Branch under the Division of Regulatory Improvement Programs. Generic communications

(except Information Notices) are further coordinated with CRGR to ensure their contents are appropriate and meet the intent of 10 CFR Part 50.109. This process assures that NRC expectations for licensee actions will be communicated through issuance of Bulletins or Generic Letters or through regulatory guides or regulations.

RECOMMENDATION 5

The NRC staff should make changes to 10 CFR 50.49 as appropriate in order to facilitate and encourage industry initiatives to improve the EQ process. Specific methodologies, techniques, and details that are acceptable to the NRC staff for establishing and maintaining EQ should be provided through Regulatory Guides, the Standard Review Plan, NUREGs, and other documents where changes can easily be made as more information becomes available and advances are made in the state of EQ technology. Guidance should also be established to address operational considerations, such as allowed outage times for EQ equipment and barriers.

Response:

The team agreed, in part, with this recommendation. The changes to 10 CFR 50.49 or other regulatory documents may be appropriate at some time in the future; however, based on the results of the work performed under the EQ TAP and GSI-168 to date, the need for changes to 10 CFR 50.49 has not been identified.

The team, however, disagreed with the recommendation that guidance should also be established to address operational considerations, such as allowed outage times for EQ equipment. Guidance is provided in Generic Letter 88-07, "Modified Enforcement Policy Relating to 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants"", GL 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability", and technical specifications. The team believes this guidance is adequate to address allowed outage times for EQ equipment that has been determined to be unqualified and/or out of service.

The team agreed with the recommendation that guidance should also be established to address operational considerations, such as allowed outage times for EQ barriers. With regard to EQ barriers, the team agreed that there is a lack of specific guidance for operational considerations. In conjunction with this issue, the staff is working with some licensees and an industry organization to determine the best way to deal not only with EQ barriers but other barriers as well. Therefore, the staff is working to address this recommendation on a generic basis, not just in the area of EQ.

RECOMMENDATION 6

In order to compensate for the various limitations and uncertainties that exist relative to equipment qualification, to provide assurance of continued qualification over time, and to identify and correct any EQ deficiencies that may exist, additional EQ programmatic requirements are necessary, including:

- periodic condition and environmental monitoring of electrical equipment, and
- rigorous identification, assessment, resolution, trending and reporting of equipment qualification problems that occur.

With regard to condition monitoring, over the next several years the NRC staff should develop, in concert with industry representatives, guidance for the application of condition monitoring techniques.

Response:

The team disagreed, in part, with this recommendation. Additional EQ programmatic requirements are not considered necessary at this time to assure qualification. We believe that current practice (primarily EQ based on type test and analysis), which is one of the options permitted by the EQ rule, provides reasonable assurance of qualification. Test margin and built-in conservatism of EQ based on type test compensate for the various limitations and uncertainties that may exist relative to equipment qualification, and provide assurance of continued qualification over time.

The team, however, agreed with the recommendation that the NRC staff should develop, in concert with industry representatives, guidance for the application of condition monitoring techniques. Condition monitoring techniques are currently being evaluated as part of the NRC's EQ Research Program. No conclusions/decisions have been reached as to the viability of condition monitoring as a method for demonstrating continued qualification or how research findings, when available and if determined viable, may be implemented. If the NRC decides to impose condition monitoring as a requirement in addition to qualification based on type test, the additional requirement would have to meet the "backfit" test of 10CFR50.109. The team believes that condition monitoring may be established as a viable approach and may be proposed for implementation by the utility industry on a voluntary basis. If this occurs, guidance will be developed in concert with industry representatives as recommended.

The team disagrees with the second recommendation. The team believes that sufficient requirements exist within the current regulatory framework of 10CFR Part 50 and its Appendices, to ensure that identification, assessment, resolution, trending, and reporting of equipment qualification problems are adequately accomplished. This conclusion is supported by the work accomplished under the EQ TAP and the ongoing work in the resolution of GSI-168. This work has not identified the need for any new requirements in this area which can be justified under 10 CFR 50.109.

RECOMMENDATION 7

The NRC staff should establish a more focused program of EQ oversight by:

- establishing a NRC Headquarters focal point responsible for identifying, monitoring, trending, cataloguing, and resolving EQ concerns on a continuing basis, and to assure consistency of regulation from one licensee to another;
- maintaining EQ guidance documents (including the SRP) up to date based on advances

that are made through research and industry initiatives;

- promulgating information and guidance to licensees and the NRC staff as appropriate;
- establishing specific reporting requirements for equipment deficiencies that indicate qualification expectations have not been satisfied for the given environment so that the staff will be better informed of EQ problems that are being identified and better able to recognize and resolve emerging EQ issues; and
- better managing and directing EQ research activities.

With regard to the NRC focal point, consideration should be given to assigning the lead responsibility for EQ of electrical equipment to an electrical discipline. Also, in the area of research, the existing NRC plan for performing EQ research [12] should be adjusted to incorporate the results of this review. For example, in addition to the need to establish condition monitoring methods and techniques (see Recommendation 6, above), further assessment is needed for a number of specific technical and equipment-related EQ concerns (discussed in Section 4.4, below). Also, recognizing that much more emphasis must be placed on periodic condition monitoring to assure continued equipment qualification, extensive efforts and expenditure of resources to correlate artificial aging with natural aging may not be warranted.

Response:

The team disagreed, in part, with this recommendation. Given the small number of EQ issues currently being promulgated, a more focused program of EQ oversight (i.e., an oversight group focused only on EQ) is not cost-effective. Regulatory processes (and requirements) currently in place and being implemented today adequately establish the recommended oversight requirements. In the early 1980s (when regulatory EQ requirements, defined by 10 CFR 50.49, were being developed and implemented), these suggested oversight requirements were performed, as recommended, by a technical group focused only on EQ. This focus was deemed necessary to establish the necessary level of EQ management supervision and NRC staff involvement for a relatively large number of EQ issues. However, today (for the relatively small number of EQ issues needing NRC staff/management involvement) responsibility for EQ oversight has been assigned to a technical group as one of several assigned responsibilities. The team believes that today's level of EQ oversight (i.e., NRC staff/management involvement) is reasonable and sufficient.

The team, however, agreed with the recommendation that consideration should be given to assigning lead responsibility for EQ of electric equipment to an electrical discipline. Lead responsibility was assigned to an electrical discipline in NRR -- the Electrical & Instrumentation and Controls Branch.

The team also agreed with the recommendation that NRC's existing plan for performing EQ research should be adjusted to include the EQ programmatic review results. Current NRC research activities has incorporate the results of the EQ programmatic review. Condition monitoring methods and techniques and also specific technical and equipment-related EQ concerns (identified as a result of the EQ programmatic review) were evaluated for the research

program.

The team disagreed with the recommendation that additional effort may not be warranted to address correlation of artificial aging with natural aging recognizing that much more emphasis must be placed on periodic condition monitoring to assure continued equipment qualification. Condition monitoring is an upcoming methodology which may (or may not) be implemented as an alternative (or supplemental) methodology for assuring (or extending) qualification. Correlation of artificial and natural aging was, thus, incorporated as part of research activities in conjunction with establishing condition monitoring methods and techniques.

RECOMMENDATION 8

Certification of EQ testing laboratories in accordance with generally accepted non-nuclear practices (e.g., ASTM or ASME certification) along with nuclear QA standards is recommended to assure that EQ testing is properly and consistently performed throughout the industry.

Response:

The team disagreed with this recommendation. Certification of EQ testing laboratories is not practicable. Current industry/NRC practices provide the necessary assurance that EQ testing is properly and consistently performed throughout the industry. Testing performed at EQ test laboratories is conducted under industry standards and Regulatory Guides including quality assurance programs meeting 10 CFR Part 50, Appendix B. Inspection of EQ test laboratories has been conducted in the past and will be conducted periodically, as needed, by the NRC to evaluate test methods and practices for compliance with 10 CFR 50.49, applicable industry standards and Regulatory Guides, licensee requirements, and their Appendix B quality assurance controls.

In addition, during the establishment of the EQ Rule, the certification of EQ test laboratories was considered and was not found to be cost effective. Therefore, it did not become a requirement. Based on the above discussion and the work on resolving the EQ TAP and GSI-168, the team has not identified sufficient information which would justify a requirement for certification of test laboratories.

RECOMMENDATION 9

To the extent that it is truly necessary for licensees to upgrade to the more rigorous EQ requirements contained in the EQ Rule, more appropriate "reasons to the contrary" should be established than those that are currently listed in Regulatory Guide 1.89. However, resolution of this concern should be coordinated with industry initiatives to improve the EQ process.

Response:

The team disagreed with this recommendation. The team is unaware of any problems with the implementation of this terminology in Regulatory Guide 1.89 nor has the industry expressed any concern with their use or the staff's interpretation of the guidance. Furthermore, the activities under the EQ TAP did not identify any specific instances where the guidance imposed unnecessary regulatory burden on the licensees. Therefore, the establishment of more

appropriate “reasons to the contrary” are considered unnecessary.

RECOMMENDATION 10

The NRC staff should determine and document to what extent single failure considerations are applicable to EQ.

Response:

The team disagreed with this recommendation. The extent to which single failure considerations are applicable to EQ have been determined and are appropriately documented. To meet requirements of the single failure criterion, all “safety-related” equipment in both divisions (trains) must be qualified. This philosophy is documented in NRC’s Regulatory Guide 1.53 which endorse IEEE Std 379-1972, “Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems”.

RECOMMENDATION 11

The staff should determine and document to what extent qualification of equipment for achieving cold shutdown is truly necessary (irrespective of licensing bases) to assure that a safety concern does not exist for those plants that were not required to qualify equipment necessary to achieve a cold shutdown condition.

Response:

The team disagreed with this recommendation. Determining and documenting to what extent qualification is required of equipment needed for achieving cold shutdown, as recommended, has already been determined through licensing and regulatory activities and is well documented. The underlying principle is, if electric equipment performs a safety function², it is safety-related and must be qualified.

RECOMMENDATION 12

The NRC staff should assure that identification and resolution of significant EQ concerns have been addressed within the scope of the IPE initiative.

Response:

The team disagreed with this recommendation. The identification and resolution of significant EQ issues is beyond the scope of the Individual Plant Examinations (IPE) initiative. The IPE scope was limited to a search for previously unidentified vulnerabilities to severe accidents. EQ issues are related to the capability of equipment to operate in a DBE environment. Environments associated with severe accidents go

²The term “safety function” is defined in IEEE Std. 603-1991. 10CFR Part 50.55a(h) incorporates IEEE Std. 603-1991, by reference.

beyond what would be expected during a DBE.

RECOMMENDATION 13

The following concerns should be further assessed by qualified EQ experts and the NRC staff to determine whether or not and to what extent additional resolution is warranted:

- a. Qualification of cold shutdown equipment and resolution of TAP A-21 may not be sufficient if single failure considerations apply (see Recommendation 10).
- b. The use of "excess margin" to justify the short-duration LOCA tests that were allowed for the DOR Guidelines plants may not be sufficient to assure equipment qualification.
- c. Generic temperature profiles that were allowed for some PWRs and BWRs were not fully justified and may not provide sufficient assurance of qualification.
- d. Resolution of TAP A-21 may not have been entirely appropriate if resolution of the "velocity profile" is dependent on the resolution of MSLB qualification for DOR Guidelines plants since the MSLB qualification issue was not fully addressed; and the "velocity profile" represents a dynamic effect that may not have been addressed in term of EQ.
- e. The use of "generic qualification" may not provide sufficient assurance of equipment qualification in those instances where this approach was used.
- f. The resolution of other issues that were handled separately from EQ but that could impact equipment qualification, such as the issues of mechanical and flow induced vibration, seismic effects, dynamic effects, etc., may have allowed EQ requirements to be compromised.
- g. Equipment survivability for severe accidents (requirement for advanced reactors) has not been addressed for operating reactors.
- h. Additional resolution of the following operating and accident considerations may be needed to assure equipment qualification:
 - leakage currents and momentary electrical effects;
 - hydrogen burn scenarios;
 - radiation and temperature stratification effects;
 - long-term exposure to moisture;
 - continuous submergence prior to the LOCA;
 - the effects of fire on EQ;
 - combustible gas and chlorine formation effects;
 - use of bulk vs. local temperatures;
 - adequacy of MSLB qualification for DOR Guidelines plants;
 - and
 - equipment interface problems.
- i. Additional assurance of qualification may be needed for the following items:

- electrical penetrations and connector assemblies;
- solenoid valves;
- EQ barrier elements;
- seals and vapor barriers;
- epoxy compounds;
- moisture intrusion through cracks;
- polyimide insulation (Kapton);
- Butyl rubber insulation;
- mineral wool insulation (especially in wet environments);
- bonded jackets;
- coaxial cable; and
- terminal blocks.

Response:

The team agreed that no further assessment is warranted. Resolution of EQ concerns (including those identified) has been further assessed through the various activities of the EQ TAP, other recent NRC activities, and the team's review of the identified issues. The objectives of the NRC's EQ literature review, analysis of literature review results, and interactions with industry groups described in response to Recommendations 1 and 3 also contributed to this assessment. As a result of these activities, the only issue still being evaluated pertains to bonded jacket cables, which are included in the ongoing research program being conducted by RES. Additionally the majority of these concerns were also debated at the Commission/ACRS level during the promulgation of 10 CFR 50.49 and were determined to be outside the scope of the EQ rule. The Commission concluded that the cost to include these items in the EQ program would be prohibitive and the incremental improvement in overall safety would likely be minimal. Some of the concerns were assessed by other NRC programs. Among these, are severe accidents, fire protection regulations and guidance, and hydrogen burn scenarios.

RECOMMENDATION 14

The process required by GL 88-07 for addressing situations where equipment is determined to be unqualified does not require that licensees seek an exemption from the EQ rule. The staff should determine whether the GL 88-07 process is appropriate given the exemption requirements stated by 10 CFR 50.12, and provide guidance as deemed necessary.

Response:

The team disagreed with this recommendation. Additional guidance, relating to the exemption requirements stated by 10 CFR 50.12, is unwarranted. The GL 88-07 process (or the justification for continued operation (JCO) process which has been outlined with respect to EQ by GL 88-07) is a short term measure. The process allows licensees to make an operability finding using analysis and partial test data. This process provides reasonable assurance that equipment will perform its safety function when called upon, even though the equipment is supposedly not qualified and does not satisfy the provisions of 10 CFR 50.49. However, ultimately, the provisions of 10 CFR 50.49 must be met. The provisions may be met, on a permanent (or long term) basis, by replacing equipment, by fully meeting 10 CFR 50.49 requirements for existing equipment, by design modification, or by exemption. The team is unaware of any regulatory issue or lack of

appropriate guidelines, relating to the implementation of these long term corrective actions, that would warrant, on a cost beneficial basis, the development of additional guidance.

RECOMMENDATION 15

There is a marked difference in requirements that were imposed for EQ of electrical equipment versus what was required for EQ of mechanical equipment, and technical justification should be established for the different standards and the different approaches that were allowed by the staff. For example, EQ of mechanical equipment did not involve prescriptive regulation, a detailed program review, and confirmatory on-site inspection.

Response:

The team disagreed with this recommendation. At the time of the development of 10 CFR 50.49, it was determined that electrical equipment is much more sensitive to the harsh environment resulting from DBEs. An electric component is more likely to fail when subjected to high radiation/temperature/moisture conditions resulting from DBEs than mechanical equipment. Mechanical equipment does not have the vulnerability to hostile environments that is considered necessary to justify prescriptive regulation, a detailed program review, and confirmatory on-site inspection. Therefore, the decision was made that the EQ rule would only apply to electric equipment.

Although there are no detailed requirements for mechanical equipment, GDC 1, "Quality Standards and Records," and GDC 4, "Environmental and Missile Design Bases," and Appendix B to 10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" (Section 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.
- 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.

RECOMMENDATION 16

The current interface that exists between the NRC and NEI is not conducive to the cooperative exchange of information and ideas that is needed for the resolution of complex technical issues. This problem between the NRC and NEI should be corrected or some other industry interface needs to be established that will allow cooperative efforts to be meaningful and productive.

Response:

The team agreed with this recommendation for the time period of the early 90s. For the past several years, as described in response to Recommendation 3, the NRC staff and the nuclear industry have openly participated in understanding and resolving EQ issues. The team felt that the

interface, that exists today between NRC and NEI, is conducive to the exchange of technical information. The NRC's efforts for cooperative exchange of information are also not limited to NEI. Other participants include NUGEQ, NUS Database EQ Group, IEEE Qualification Subcommittee, IAEA and international EQ experts.

4.0 CONCLUSIONS

The team concluded that the recommendations (1) are currently incorporated in the staff's efforts to resolve GSI-168; (2) were addressed in EQ-TAP and GSI-168; (3) are being addressed in other NRC ongoing programs; (4) have been addressed in the past by NRC and industry and no further action is appropriate; or (5) further action cannot be justified based on a cost benefit basis. Therefore, no additional activities are recommended.