UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 4, 1997

MEMORANDUM FOR: Gus C. Lainas, Acting Director
Division of Engineering
Office of Nuclear Reactor Regulation

FROM: Gary Holahan, Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: ENVIRONMENTAL QUALIFICATION TASK ACTION PLAN ITEMS:
3. PROGRAMMATIC REVIEW AND 5. RISK ASSESSMENT

Since you have the responsibility for environmental qualification (EQ) function in NRR for operating nuclear power plants and will have full responsibility for EQ with the closure of the Environmental Qualification Task Action Plan (EQ-TAP), this memorandum is to inform you of the results of my review of two specific activities performed as part of the EQ-TAP. The first activity pertains to a programmatic review of EQ (Item 3 of the EQ-TAP) and the other pertains to risk assessment activities (Item 5). Discussions of these items are provided below with my recommendations for any further actions.

PROGRAMMATIC REVIEW

The staff's assessment of the NRC fire protection program dated February 27, 1993, identified a number of weakness in the fire protection program and made specific recommendations for programmatic improvements. In view of the weakness that were identified relative to the program, the staff determined that other programs such as EQ should also be reviewed to identify any programmatic weakness that may exist. Item 3, Programmatic Review of the EQ-TAP, was established to determine if there were similar programmatic weakness in the EQ program. In order to perform the review, the following specific tasks were defined:

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

The objectives of 3.g was to: (a) consolidate the potential issues that were identified while completing Items 3.a through 3.f; (b) validate the issues through a peer review process involving individuals who are experienced and knowledgeable in the area of EQ; and (c) make recommendations for further action. Attachment 1 is a draft of the report which documents the results of 3.g. efforts. The report was never formally issued.

As part of my review of the results of 3.g, draft versions of the report were provided to individuals in AEOD, RES, and NRR. Based on comments received and my own review of the report, I have determined that the most significant item identified under the programmatic review was the lack of a feedback mechanism in the EQ program as it exists today. The concept of a feedback mechanism (i.e. a condition monitoring or inservice inspection program) was discussed in the November 15, 1997 EQ-TAP Status Update Report to the Commission. While the NRC and industry have gone to great lengths to establish and document the qualification of electrical equipment over the past 25 or more years, there has been no requirement within the EQ regulatory framework for licensees to verify that the assumptions and parameters used during the design, qualification, and installation of equipment within the scope of 10 CFR 50.49 continue to be valid as nuclear power plants continue operation.

Based on the above, I recommend that DE follow the RES EQ Program Plan being performed by RES relative to electrical cable testing and condition monitoring. Once RES efforts have been completed and if they provide a technical basis for a feedback system, DE should perform a regulatory analysis to determine if a feedback mechanism can be justified for qualified electrical equipment. In the performance of a regulatory analysis, the approach used in the amendment to 10 CFR 50.55a, "Codes and Standards for Nuclear Power Plants; Subsection IWE and Subsection IWL," published in August 8, 1996, (61 FR 41303) may be helpful. This amendment promulgated requirements for inservice inspection of containment structures.

With regard to the other recommendations made in the report, I do not feel that any further action is warranted under Item 3 of the EQ-TAP. However, you may want to review the recommendations and consider them in any EQ activities you undertake in the future.

RISK ASSESSMENT

Item 5, Risk Assessment, was included in the EQ-TAP to ensure that risk insights were considered in the review of EQ concerns and consisted of the following specific tasks:

5.a Perform Preliminary Risk Scoping Study

5.b Perform Final PRA

5.c Incorporate Probabilistic Risk Assessment Insights

Item 6.a was a preliminary scoping study to quantify the impact on core damage frequency (CDF) of environmentally qualified electrical equipment. This study was completed in April 1993 and details of the study are documented in attachment 2. The major conclusions of the study were: (1) EQ failures could have significant risk impact if electric component reliabilities are reduced in the presence of a harsh environment; (2) the magnitude of the impact on CDF is plant specific; and (3) lack of reliability data bases and limitations in current probabilistic risk assessment models resulted in significant uncertainty in the preliminary results.

Item 6.b was established to determine whether data existed that could be used to perform a more accurate PRA. This effort consisted of a staff review of the findings of the initial scoping study, a follow-up study by Argonne National Laboratory to search the existing literature for reliability data for electrical components, and a Brookhaven National Laboratory literature review (EQ IAP Item 4.a). Based on the results of the staff review, a final draft report was issues in April 1996 (see attachment 3) on issues regarding EQ equipment. This report summarized previous work performed in the area of PRA and EQ and concluded that available information and data is not adequate to support a more detailed PRA of EQ issues; therefore further work on PRA should not be performed under the EQ-IAP.

Item 6.c was established to ensure that risk insights from the EQ-IAP were incorporated in the other activities of the action plan. While the staff considered the results of the preliminary scoping study during the preparation of the action plan, other uses of risk insights was dependent upon the results of Item 6.b.

In connection with these risk related activities, I have discussed their results with my staff, including the division's senior level advisor on probabilistic safety assessment. Based on these discussions, the advisor's review of available EQ and risk information, the fact that environmental qualification tests were not designed to provide reliability data, and that no reliability testing has been performed for equipment in a harsh environment, I have concluded that additional risk related efforts under the EQ-IAP are not warranted.

While I have concluded that no further risk efforts are warranted under the action plan, there are two potential uses of PRA that may be helpful in any future EQ activities that may be performed by DE. These potential uses are discussed in attachment 4. The method which might provide the most use in the near term is the use of PRA to focus any feedback system on the equipment with the most risk significance.

Gus C. Lainas

CONCLUSIONS

Based on my above review and conclusions associated with the Programmatic Review and Risk Assessment of the EQ-TAP, I have determined that the work performed under Items 3 and 5 of the action plan is adequate to close the specific tasks. Therefore, the next EQ-TAP update will reflect the closure of these two actions.

If you have any questions contact George Hubbard, extension 2870, of the Plant Systems Branch.

Attachments: As stated

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ATTACHMENT 1

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

FROM: Gary M. Holahan, Director
Division of Systems Safety and Analysis

SUBJECT: SUMMARY REPORT ON THE EQUIPMENT QUALIFICATION (EQ) PROGRAMMATIC REVIEW (EQ-TAP ACTION ITEM 3.g) (TAC M85648)

As discussed in the staff's Environmental Qualification Task Action Plan (EQ-TAP) of June 16, 1993, we are performing a programmatic review of 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) was to identify potential EQ issues and concerns that may deserve further staff consideration. This preliminary part of our programmatic review was not intended to resolve or to otherwise address any of the EQ issues that were identified. After completing items 3.a through 3.f, the next step in the process was to consolidate and specifically address all of the EQ issues in our final report under EQ-TAP Action Item 3.g, "Finalize Review Results," and to make recommendations as appropriate. We have now completed our actions associated with Item 3.g of the EQ-TAP, and our final report on the EQ programmatic review is included as an attachment to this memorandum.

The programmatic review that was outlined in the EQ-TAP was quite extensive and consequently, many potential issues were identified for further consideration. However, I must emphasize that none of the issues are considered to be an immediate safety problem and we did not identify any

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415-2805

specific equipment items that are not qualified. In general, the overall results of our EQ programmatic review indicate that: (a) some adjustments are needed to better assure continued qualification of electrical equipment over the projected lifetimes of the equipment; (b) some of the past EQ concerns require further review to assure that resolution is complete or that a significant safety problem does not exist, and (c) a structured program of ongoing NRC involvement and oversight is needed. Our EQ program assessment and recommendations are discussed in Section 4.0 of the attached report, and our conclusions are stated in Section 5.0.

We are now proceeding to update our EQ-TAP and the RES EQ program plan based on the recommendations that have been made and, as part of this process, we will place the EQ program review reports in the PDR and meet with industry representatives to discuss the staff's recommendations. I will keep you informed of our progress and future plans as they develop.

Attachment: EQ Programmatic Review - Summary Report (EQ-TAP Action Item 3.9)

specific equipment items that are not qualified. In general, the overall results of our EQ programmatic review indicate that: (a) some adjustments are needed to better assure continued qualification of electrical equipment over the projected lifetimes of the equipment; (b) some of the past EQ concerns require further review to assure that resolution is complete or that a significant safety problem does not exist, and (c) a structured program of ongoing NRC involvement and oversight is needed. Our EQ program assessment and recommendations are discussed in Section 4.0 of the attached report, and our conclusions are stated in Section 5.0.

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Attachment: EQ Programmatic Review - Summary Report (EQ-TAP Action Item 3.9)

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EQ Programmatic Review - Summary Report
(TAC M85648)

1.0 INTRODUCTION

In response to issues that were raised by the Office of the Inspector General (OIG) in a report dated August 12, 1992, the staff completed an assessment of the NRC fire protection program. As a result of this review, the staff identified a number of weaknesses and made specific recommendations for programmatic improvements in a report that was issued on February 27, 1993. In view of the weaknesses that were identified relative to the NRC fire protection program, the staff concluded that other programs that are similar in nature to fire protection, such as environmental qualification (EQ), should also be reviewed to identify and correct any programmatic weaknesses that may exist.

Independent of the staff's reassessment of fire protection, EQ was identified as an area that required further review as a result of the staff's activities related to license renewal. As discussed in SECY-93-049, a major concern related to EQ was whether the EQ requirements for older plants were adequate to support license renewal. Consequently, the staff concluded that differences in EQ requirements between older and newer plants constituted a potential generic issue which should be evaluated for backfit independent of license renewal activities.

In support of the license renewal initiative, EQ testing of electric cables was performed by Sandia National Laboratories (SNL) under contract with the NRC. Some tests were performed to determine the effects of aging on typical electric cable products used in nuclear power plants and other tests (unrelated to license renewal) were performed to assess the functionality of damaged electric cables during loss-of-coolant accident (LOCA) conditions. After accelerated aging, some of the environmentally qualified cables either failed or exhibited marginal insulation resistance during accident simulation. While some of the SNL tests may have been more severe than required by NRC regulations, the test results raised questions with respect to the environmental qualification and accident performance capability of certain artificially aged electric cables [1-5].

In order to assess the significance of EQ, the NRC staff performed a preliminary risk scoping analysis on the potential impact of inadequate equipment qualification on core damage frequency. The scope of the analysis was limited to core damage prevention considering internal events only with postulated failures of in-containment electrical equipment, with emphasis on electric cables. The major conclusions of the preliminary risk scoping analysis were: (1) EQ failures could have significant risk impact if electrical component reliabilities are reduced in the presence of a harsh environment; (2) the magnitude of the impact on core damage frequency is plant specific; and (3) the lack of reliability data and limitations in current probabilistic risk assessment models result in significant uncertainty. Based on the results of the preliminary risk scoping study, the staff concluded that a more detailed EQ risk assessment should be completed.

Thus, the current EQ issue is one that pertains to operating reactors, but

resolution is also important to the plant life extension initiative. The staff issued an Environmental Qualification Task Action Plan (EQ-TAP) on June 16, 1993, in order to define and coordinate the actions that are necessary to resolve this issue. Action Item 3 of the EQ-TAP lists those actions that pertain to the programmatic review of EQ, which include:

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

This report is intended to address EQ-TAP Action Item 3.g, "Finalize Review Results," and represents the overall results of the staff's EQ program review. Section 2.0 of this report discusses the review methodology, Section 3.0 is a summary of the potential issues that have been identified while completing EQ-TAP Action Items 3.a through 3.f, Section 4.0 provides the staff's assessment and recommendations, and the conclusions are contained in Section 5.0.

2.0 REVIEW METHODOLOGY

The goal of the EQ program review was to take a fresh look at what has been done to address EQ issues and concerns and to identify whether any significant issues or concerns currently exist that need to be resolved. The various elements of the EQ program review are outlined under Action Item 3 of the EQ-TAP (discussed above).

In completing EQ-TAP Action Items 3.a through 3.f, the goal was simply to identify potential issues that may exist. It is important to recognize that the potential issues that were identified are rather speculative, since they were generated based on the specific information that was reviewed and no attempt was made to pursue any of the postulated issues to determine if they had somehow been resolved by the staff. Also, in order to assure objectivity, EQ-TAP Action Items 3.a through 3.f were completed by individuals who were not previously associated with EQ and who were therefore not familiar with how specific EQ problems were dealt with in the past.

The objectives of this review (EQ-TAP Action Item 3.g) are to: (a) consolidate the potential issues that were identified while completing EQ-TAP Action Items 3.a through 3.f; (b) validate the issues through a peer review process involving individuals who are experienced and knowledgeable in the area of EQ (i.e., NRC staff, contractors, and industry experts); and (c) make recommendations for further action.

3.0 ISSUE SUMMARY AND CONSOLIDATION

The programmatic review that was outlined in the EQ-TAP was quite extensive and consequently, many potential issues were identified for further consideration. Appendix A is a consolidated listing of the potential issues that have been identified while completing EQ-TAP Action Items 3.a through 3.f, eliminating duplication between the various EQ-TAP reports that have been issued [6-11]. The potential issues are organized into one of the following sections of the appendix, depending on the general nature of the issue:

A. Scope/Applicability (page A-1)

B. EQ Methodology (page A-16)

C. Current Status and Implementation (page A-71)

D. Assurance of Continued Qualification (page A-81)

E. Equipment-Related Issues (page A-93)

F. NRC Oversight (page A-101)

G. Miscellaneous Peer Review Comments (page A-115)

The consolidated listing of potential EQ issues was reviewed by the NRC staff and others who are experienced and knowledgeable in EQ, and the comments that were received during this peer review process are included in the appendix along with the listing of potential issues and problem statements to provide a balanced perspective. Appendix A also includes the staff's assessment of the potential EQ issues that have been identified. The following summary of the information contained in Appendix A provides the overall results of the EQ programmatic review:

A. <u>Scope/Applicability Issues</u>

The EQ programmatic review found that inconsistencies exist relative to the scope and applicability of EQ requirements. In particular:

- single-failure requirements have not been applied consistently (e.g., single failure criteria was not imposed for qualification of cold shutdown equipment, and the staff's resolution of TAP A-21 regarding the "super heat" effects of a main steam line break did not include single failure considerations);

- the need for single-failure protection is not clear if the purpose of EQ is to protect against the occurrence of "common cause" or "common mode" failures;

- being able to reach hot shutdown was a qualification factor for some plants while being able to reach cold shutdown was the consideration for other plants;

- qualification of mechanical equipment has not been addressed in the same fashion as qualification of electrical equipment; and

- electrical equipment located outside [illegible] is subject to the same EQ rigor as electrical equipment [illegible]

b. EQ Methodology Issues

Many of the potential issues that were identified during the EQ program review are related to either: (a) justification of the EQ methodology that has been imposed, or (b) resolution of technical issues related to qualification testing. With regard to (a), many facets of the methodology for establishing the initial qualification of electrical equipment for "harsh environment" conditions evidently were not justified on a rigorous, technical level. In particular:

- current requirements vs. what is reasonably possible within the state-of-the-art capabilities;
- imposition of different qualification standards depending on plant vintage;
- age conditioning/preconditioning requirements;
- use of generic temperature profiles;
- qualification based on bulk vs. local temperatures; and
- test margin requirements

With regard to (b), resolution of many technical issues relative to qualification testing were identified for further review and follow-up action, including:

- certification of testing laboratories;
- definition of "worst-case" electrical conditions;
- leakage current considerations;
- MSLB vs. LOCA qualification requirements;
- effects of long-term exposure to moisture;
- combustible gas and chlorine formation effects;
- dust effects;
- mechanical and flow-induced vibration effects;
- seismic and dynamic effects; and
- fire scenario considerations.

c. Current Status and Implementation Issues:

The staff's review under EQ-TAP Action Item 3.e [10] generally found

that the current status and implementation of EQ requirements is well understood. While resolution of many of the administrative and minor EQ issues that were raised with individual licensees may not have been well documented, licensees typically recognized these as valid issues during meetings with the NRC staff and agreed to correct discrepancies of this nature. Therefore, for purposes of the EQ program review, the staff considered this matter to be of minor importance. However, as a result of the evolving nature of EQ requirements, the staff may not have been entirely clear on what requirements were being superseded during development and promulgation of the EQ rule and there may be some confusion in the industry on this point. Also, to the extent that "generic qualification" (as in qualification of a generic type of insulation, for example) was credited, which evidently was the case for some licensees, further review and justification may be necessary since this approach was later found to be unacceptable.

d Assurance of Continued Qualification:

The EQ programmatic review found that current qualification practices (i.e., initial equipment qualification certification without periodic monitoring and assessment) may not provide assurance of continued qualification of electrical equipment over time, recognizing that:

- substantial uncertainty exists in the qualification process, especially in the ability to accurately project a "qualified life;"
- installation, maintenance, and surveillance practices can have a degrading effect on equipment qualification; and
- unanticipated conditions and occurrences that take place over the life of the plant can have a negative effect on equipment qualification.

Also, "reasons to the contrary" for not upgrading replacement equipment to current requirements appear to be without merit since more than enough time has passed to allow licensees to establish programs for qualifying equipment to current requirements. In particular, "reasons to the contrary" that are suspect include:

- the item is part of a piece of equipment that was qualified as an assembly;
- the item was on hand as part of the utility's stock prior to February 22, 1983;
- replacement equipment qualified in accordance with the provisions of 10 CFR 50.49 does not exist; and
- the use of replacement equipment qualified in accordance with the provisions of 10 CFR 50.49 would have a significant probability of creating human factors problems.

e. Equipment-Related Issues:

During the EQ programmatic review, a number of equipment items were identified that may deserve further review and consideration by the staff to assure that the existing level of qualification is adequate. In particular:

- some electrical components such as penetrations and connector assemblies may be more critical than electrical cables and on this basis, more attention may be warranted for these components;

- moisture transmission through cracks in cable insulation or into the cable core through diffusion may pose significant problems;

- solenoid valves, EQ barrier elements, equipment seals and vapor barriers (especially on plants that are subject to the DOR Guidelines), and epoxy compound used for potting electrical penetrations may deserve further scrutiny; and

- the use of polyimide insulation (Kapton), Butyl rubber insulation, mineral wool insulation (especially in wet and humid environments), bonded jackets, coaxial cable, and terminal blocks may need to be better defined and/or justified.

f. NRC Performance and Oversight Issues:

Given the evolving nature of EQ and the uncertainties that are involved, it appears that NRC efforts to address and resolve this issue have not been altogether sound. For example:

- the ability to determine a "qualified life" by age conditioning techniques seems highly questionable;

- the imposition of different, more rigorous standards for the newer plants was not technically justified by the staff;

- the prescriptive regulatory posture that the staff took relative to EQ seems counterproductive and may have inhibited progress and innovative approaches for resolving this complex issue;

- the staff failed to include allowances in the EQ rule for the temporary removal of EQ barriers to facilitate maintenance, surveillance, and replacement activities; and

- no extension period beyond the end of qualified life (similar to the 25% extension that is typically allowed for completing surveillance requirements) was established to allow flexibility for equipment replacement during the next scheduled outage.

Additionally, based on the information that was reviewed under the EQ-TAP, it appears that continued NRC oversight and follow through to monitor and assure issue resolution have not been sufficient. For example:

[illegible] activities have not been very successful in [illegible] the EQ issues that were initially identified;

- NRC programs and initiatives have not been established to continually monitor progress and to restructure, redirect, and improve EQ program requirements as appropriate;

- NRC review and inspection programs have not been maintained in the area of EQ;

- reporting requirements have not been established to assure that emerging EQ-related problems are referred to the NRC staff for consideration and appropriate resolution; and

- Generic Letter 88-07 does not require that licensees request an exemption from the EQ rule for equipment found to be unqualified which appears to be inconsistent with 10 CFR 50.12 requirements.

Finally, based on severe accident considerations and based on difficulties that have been observed in dealing with EQ problems, three additional issues were identified which were not previously discussed in the EQ-TAP reports that have been issued. Specifically:

g. NEI/NRC Interface:

The current interface that exists with the Nuclear Energy Institute (NEI) often does not allow for the objective and unbiased exchange of information on a purely technical level. Licensee representatives, industry representatives, and NRC staff are sometimes frustrated by the NEI interface when trying to resolve technical issues in a cooperative manner. It is important that this problem be resolved to allow for a cooperative effort in addressing EQ issues and other issues that are important to the staff and the nuclear industry.

h. Lead Review Responsibility:

- Although EQ deals primarily with electrical equipment and it is typically subject to electrical industry standards, an electrical discipline within the NRC is currently not assigned the lead responsibility for this area of review. Design considerations specific to electrical equipment that are important for equipment qualification are more apt to be overlooked or misunderstood under the current arrangement, and the staff is at a clear disadvantage when interfacing with industry experts on important EQ issues that affect electrical equipment. This assignment of staff resources appears to be inefficient.

i. Equipment Survivability:

Equipment performance requirements for the advanced reactor designs include survivability criteria for severe accidents in addition to EQ requirements for design basis accidents. However, equipment survivability for severe accidents has not been addressed for operating reactors.

4.0 EQ PROGRAM ASSESSMENT AND RECOMMENDATIONS

To a large extent, the potential issues that were identified during the EQ programmatic review deal with limitations and uncertainties that exist in the qualification process, and it appears that there are programmatic weaknesses and lingering technical and equipment-related concerns that require further attention. While much has been done over the past 25 years to try to better understand EQ, a clear strategy for the long-term resolution of EQ issues is not readily apparent and existing requirements have not evolved over the years to account for the uncertainties that are inherent in the EQ process. The discussion and specific recommendations that follow are intended to establish a strategy for assuring qualification of electrical equipment over its installed lifetime. This is an integrated approach and as such, some of the recommended actions are desirable program enhancements while others are considered necessary in order to assure an adequate level of equipment qualification. Those recommendations that are considered to be desirable program enhancements are listed in brackets.

In addition to the regulatory perspective that is presented by this report, it is important to recognize that EQ programmatic improvements may also be possible and of substantial benefit from an industry perspective. For example, it may be possible to better focus EQ requirements by using graded QA requirements and PRA techniques; better definition of the role that single failure plays relative to EQ could result in better-directed qualification requirements; and stress testing may prove to be a viable alternative to preaging. Therefore, in addition to the specific recommendations that are discussed below, the NRC staff should actively support and encourage industry initiatives to improve and streamline EQ requirements, methods, and practices.

4.1 General Considerations

In pursuing EQ programmatic improvements and addressing specific equipment concerns, it is important to make use of information that has been developed through research activities, operating plant experience, and the advice of qualified experts. The NRC staff should work closely with industry experts in addressing current and future EQ issues and equipment concerns, taking full advantage of other initiatives such as the maintenance rule and graded quality assurance as appropriate. EQ requirements tend to be very costly for licensees and any changes to existing program requirements or further expectations of licensees should be well justified and properly communicated.

The following recommendations are directed toward satisfying these fundamental concepts:

[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

... obtained; and (c) the cost ... in terms of the expected ... benefits to public health ...

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.

[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.]

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.

4.2 EQ Rule

The EQ rule (i.e., 10 CFR 50.49) was established before much of the research on EQ was completed and the rule is outdated in this respect. For example, the rule requires that a qualified life be determined as part of the equipment qualification process, but such a determination is theoretical, the effects of many degrading influences cannot be accelerated, and the accuracy of such a determination is unknown. A rule that is more general would be better suited to the theoretical nature of EQ and the uncertainties that are involved, and would more readily allow the NRC staff and industry experts to pursue other approaches and methodologies for addressing EQ concerns. Also, while the EQ rule does not preclude allowed outage times for EQ barriers and equipment, guidance has not been established in this area.

[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.]

4.3 EQ Programmatic Weaknesses

The potential issues that were identified during the EQ programmatic review indicate that EQ requirements are not commensurate with limitations and uncertainties that exist in the qualification process. For example, the assignment or determination of a qualified life is theoretical, the effects of many degrading influences cannot be accelerated, and the accuracy of such a determination is unknown. There is also uncertainty as to how well the qualification requirements account for such things as equipment installation, normal wear and tear, and periodic maintenance and surveillance activities. Another uncertainty factor that bears on the long-term qualification of electrical equipment is that different qualification standards have been imposed over time depending on plant vintage. For example, the older plants were not required to preage electrical equipment prior to qualification testing. Therefore, in order to account for the various limitations and uncertainties that exist and to provide adequate assurance of EQ for electrical equipment over time, additional measures must be taken.

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.

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 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.

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.

[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.]

Various Technical and Equipment-Related Concerns

In addition to the programmatic weaknesses that were identified during the EQ programmatic review, a number of technical and equipment-related concerns were identified for further consideration. Most of these are not issues in the sense that problems are known to exist but rather, they are speculative concerns that stem from the early evolution of EQ requirements and the various uncertainties that are associated with the qualification process. The following recommendations are for concerns of this nature:

RECOMMENDATION 10

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

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.

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.

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

[illegible] addressed; and the "velocity profile" represents a dynamic effect that may not have been addressed in terms 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.

4.5 Other Considerations

A few questions were raised as a result of the EQ programmatic review that don't relate specifically to EQ, but may warrant clarification or further

[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.]

[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.]

[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.]

5.0 CONCLUSIONS

The EQ programmatic review identified many potential issues, ranging from uncertainties associated with the qualification process to potential equipment vulnerabilities. It must be emphasized that these are *potential issues*, some of which may be readily dismissed based on more in-depth review or expert judgement. Also, while it is important to recognize and appreciate the various potential EQ issues that have been identified during the EQ programmatic review, it is also important to recognize the limitations that exist in the state of technology and in the ability to address and resolve these issues. Consequently, resolution of EQ issues in general requires a good understanding of the overall strategy for addressing EQ on a programmatic level, an understanding of what can reasonably be achieved, and the use of good judgement in deciding how to proceed on a given issue.

From a program perspective, the results of this review indicate that a strategy does not currently exist for assuring qualification of electrical equipment on a long-term basis. Given the uncertainties that exist, the current requirement of initial EQ certification must be supplemented with additional requirements for ongoing assessment, validation, and NRC oversight. In particular, program enhancements are needed that include: (a) periodic condition monitoring of EQ equipment; (b) rigorous identification, assessment, resolution, trending, and reporting of equipment qualification problems that

and (c) a structured program of NRC oversight. By including these as fundamental elements of EQ program requirements, uncertainties associated with the initial qualification process and questions about the specific methodologies that were used become much less important.

Many of the specific concerns that have been identified can most likely be addressed 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. Additionally, 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, further assessment is needed for a number of specific technical and equipment-related EQ concerns. 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.

Aside from the recommendations contained in this report, additional adjustments in existing EQ requirements may be possible and of substantial benefit to the nuclear industry. This is especially true recognizing that more emphasis is needed on maintaining equipment qualification over time and some "trade-offs" may be appropriate. For example, it may be possible to better focus EQ requirements by using PRA techniques. Better definition of the role that single failure plays relative to EQ could result in better-directed qualification requirements, and stress testing may prove to be a viable alternative to preaging. The NRC staff should encourage and be supportive of industry initiatives to: (a) improve and streamline EQ requirements, methods, and practices based on the knowledge that has been developed over the last two decades; and (b) use PRA and other techniques to better focus EQ requirements and to help place EQ issues in proper perspective. Changes in the regulation (10 CFR 50.49) should be initiated by the staff to facilitate this approach.

In pursuing the recommendations contained in this report and in addressing EQ issues in general, the NRC staff should work closely with industry experts, taking full advantage of other initiatives such as the maintenance rule and graded quality assurance as appropriate. Because the existing interface with NEI seems to inhibit this sort of cooperative effort, it is important that NRC management either resolve this problem with NEI or establish other avenues for industry participation.

The programmatic weaknesses and equipment-related concerns that were identified as a result of the EQ program review do not mean that equipment is currently not qualified. Rather, the results of this review indicate that: (a) some adjustments are needed to better assure continued qualification over the projected lifetime of the equipment that is qualified; (b) some of the past EQ concerns require further review to assure that resolution is complete; and (c) a structured program of on-going NRC involvement and oversight is needed. Until such time that specific equipment qualification deficiencies are identified, existing qualification is assured by the initial qualification

testing that was performed, twenty-five years of research, and equipment performance and operating experience. None of the issues that were identified during this review was considered to be an immediate safety problem.

Principal Contributor: J. Tatum, NRR/SPLB

REFERENCES

1 NUREG/CR-5772, "Aging, Condition Monitoring, and Loss-of-Coolant Accident (LOCA) Tests of Class 1E Electrical Cables -- Crosslinked Polyolefin Cables," Volume 1, August 1992

2 NUREG/CR-5772, "Aging, Condition Monitoring, and Loss-of-Coolant Accident (LOCA) Tests of Class 1E Electrical Cables -- Ethylene Propylene Rubber Cables," Volume 2, November 1992

3 NUREG/CR-5772, "Aging, Condition Monitoring, and Loss-of-Coolant Accident (LOCA) Tests of Class 1E Electrical Cables -- Miscellaneous Cable Types," Volume 3, November 1992

4 NRC Information Notice (IN) 92-81, "Potential Deficiency of Electrical Cables with Bonded Hypalon Jackets," December 11, 1992

5 NRC Information Notice 93-33, "Potential Deficiency of Certain Class 1E Instrumentation and Control Cables," April 28, 1993

6 Memorandum from M. J. Virgilio to A. C. Thadani, "Review of EQ Information Related to Plant License Renewal (EQ-TAP Action Item 3.a) (TAC M85648)," March 22, 1994

7 Memorandum from M. J. Virgilio to A. C. Thadani, "Review of Fire Protection Reassessment Report (EQ-TAP Action Item 3.b) (TAC M85648)," May 10, 1994

8 Memorandum from M. J. Virgilio to A. C. Thadani, "Results of the Survey of EQ Experts (EQ-TAP Action Item 3.c) (TAC M85648)," June 12, 1994

9 Memorandum from G. M. Holahan to A. C. Thadani, "Review of Existing Environmental Qualification Program Requirements (EQ-TAP Action Item 3.d) (TAC M85648)," December 21, 1994

10 Memorandum from G. M. Holahan to A. C. Thadani, "Results of the Review of NRC Audit/Inspection Practices (EQ-TAP Item 3.e) (TAC M85648)," dated April 14, 1995

11 Memorandum from G. M. Holahan to A. C. Thadani, "Licensee Implementation Practices Relative to EQ (EQ-TAP Action Item 3.f) (TAC M85648)," October 7, 1994

12 Memorandum from L. C. Shao to A. C. Thadani, "Research Program Plan for Environmental Qualification of Electric Equipment," dated July 7, 1994

APPENDIX A

Potential EQ Issues
(Consolidated Listing with Peer Review Comments and Staff Assessment)

A. Scope/Applicability of EQ

1. Qualification of components other than cables has not been rigorously addressed. For example, research is only just beginning to assess the adequacy of EQ for RG 1.97 functions and very little EQ research has been performed on pressure switches, RTDs, pressure transmitters, and valve operators.

Peer Review Comments:

a. Qualification of components other than cables have been vigorously addressed. During the EQ inspections that were conducted in Region 3, all components required to function in a harsh environment were required to be qualified. Qualification testing was noted for valve operators, transmitters, pressure switches, etc. However, when considering license renewal and the possibility of exceeding the 40-year qualified life, it does appear that cables have received more review/research than other components. As for RG 1.97, only certain components are required to be EQ qualified so the basis for the concern is not clear.

b. Why do we need research? Units have been qualified.

c. The first sentence can be extremely provocative, depending on the interpretation of "rigorously" addressed. By the late 1980s standards, we [NRC staff] saw a lot of "qualified" components in licensee "EQ" inspections. Ditto for vendor inspections. If standards are different now, this document should clarify -- otherwise you'll have readers saying that nothing is qualified.

d. I disagree. This is not considered an open EQ issue.

First, the industry has addressed qualification in accordance with requirements of the IEEE standards and NRC documents. If they were acceptable as rigorous for cables, then the other items are in the same league, and in my opinion, even better in some cases (e.g., transmitters, batteries, some valves). Remember that the industry standards on qualification for various classes of equipment have had NRC input, and that NRC has not thus far (with a few exceptions) indicated any serious disagreements with these standards by issuing Regulatory Guides, as is the common NRC practice.

Second, if the concern relates to the extent of NRC sponsored research on items other than cables, then we must keep in mind that Sandia, Oakridge, FRC, and if I am correct, even Wyle has performed research on many items other than cables.

Third and last, it is time to ask if we have not reached a point of diminishing returns in EQ research by performing more aging and LOCA tests. Time and again research conducted to date have pointed to the crying need for improvements in the methods used for equipment surveillance and condition monitoring. In other words, predictive maintenance and condition monitoring techniques should be used to supplement EQ.

Therefore, I believe that we must focus our scarce resources towards understanding the results of the work already performed and using them beneficially to develop and implement effective condition monitoring methods.

e. The concern is valid.

f. I am not clear how "rigorously" is defined. What kind of EQ research needs to be performed?

g. During the NRC EQ research performed at Sandia, research was performed on the EQ process. This included artificial aging, radiation simulations and LOCA testing. Several equipment types were tested including connectors, penetrations, and solenoid valves.

h. Industry responsibility. After about two decades of research (in other countries as well as in the USA) and the expenditure of many millions of dollars, we are still far from answering all the questions about cable qualification. It would be futile to undertake research on the components listed in this paragraph as a way of learning how to qualify them. As indicated in comments that follow on other issues, it is time to take stock of what we have learned and look for ways to simplify qualification without reducing the assurance of safety.

i. The requirements for environmental qualification of electrical equipment important to safety for nuclear power plants is codified in 10 CFR 50.49 (also known as the final rule on environmental qualification), and is dated January 21, 1983. In accordance with a referenced footnote in paragraph (b)(3) 10 CFR 50.49, and in accordance with the NRC staff's findings based on information provided by utilities, components provided in plants are qualified and adequate to provide Regulatory Guide (RG) 1.97 functions. However, additional research in this area is welcome. Remember, licensees are responsible for qualifying all equipment that is required to be qualified, therefore statements such as this one should be directed to licensees.

Staff Assessment:

Research is good to a point, but there are limitations to what can be accomplished. The NRC staff should assure that the results of past research efforts are understood and related to specific equipment applications, as appropriate. Any further research should: a) be based

... a well defined need for additional information, b) be pursued only if there is a good likelihood that the desired information will be obtained, and c) be pursued only if the cost of research is justified in terms of the expected benefit to public health and safety. The staff agrees with the view expressed by Comment 1.h that "...it is time to take stock of what we have learned and look for ways to simplify qualification without reducing the assurance of safety" and industry initiatives in this regard should be encouraged. The staff should assure that full advantage is taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct EQ deficiencies on an ongoing basis.

2. Even though the Standard Review Plan suggests that NUREG-0588, RG 1.89, and IEEE 323 may be applicable for qualification of mechanical equipment, specific guidance has not been provided in this regard.

Peer Review Comments:

a. The need for additional guidance is not clear unless the issue deals with life extension.

b. I disagree. How about the ASME QME Committee documents (QR and QV series)? These have been under development over the past seven+ years and were finally issued in 1994. They were specifically written to address Mechanical Equipment Qualification (MEQ). It is my understanding that NRC has participated in their development.

On a different note, let us recognize that the industry effort in establishing MEQ in plants licensed to operate since 1980 have conclusively established that the effort boils down to identifying and evaluating (mostly by analysis only) nonmetallics. The information from this analysis is used to establish replacement intervals for the soft parts. Further, recently the industry has applied for exemptions from the requirement to treat MEQ as a separate program and integrating them into the preventive maintenance programs. Apparently, the NRC has acquiesced with these exemption requests. If so, I am not sure what the basis is for this issue listing.

c. This is a valid issue.

d. I believe that there is an ASME, EQ document that refers to mechanical equipment.

e. Several of the NTOL plants were required to have mechanical EQ programs during the 1980's. The basic findings were that the most sensitive aging components were seals (O-Rings, Gaskets, and diaphragms). Seal replacement programs were established. Mechanical items such as snubbers are required to be periodically tested. Some mechanical actuators have been EQ qualified such as pneumatic and hydraulic actuators. Motor operators, such as

Limitorque, Rotorque and ITT were qualified. Generic Letter 85-03 and 89-10 have required a version of qualification by assuring that MOV's have their operability demonstrated during worst case flow, including blowdown conditions.

f. Merits analytical resolution (i.e., analysis of existing information is warranted to reach resolution).

g. As is indicated in your statement, the referenced documents (NUREG-0588, RG 1.89 and IEEE 323-1974) *may be applicable* for qualification of mechanical equipment. Nevertheless, the NRC staff has provided specific guidance for developing programs for environmental qualification of mechanical equipment. A copy of that guidance follows:

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

- Measures shall be established for the selection and review for suitability of application of materials, parts and equipment that are essential to safety-related functions.

- Design control measures shall be established for verifying the adequacy of design.

- Equipment qualification records shall be maintained and shall include the results of tests and materials analyses.

For mechanical equipment, the staff review will concentrate on materials which are sensitive to environmental effects, for example, seals, gaskets, lubricants, fluids for hydraulic systems, diaphragms, etc. A review and evaluation should be performed by the applicant that includes the following:

(1) Identification of safety-related mechanical equipment located in harsh environment areas, including required operating time.

(2) Identification of non-metallic subcomponents of this equipment.

(3) Identification of the environmental conditions this equipment must be qualified for. The environments defined in the electrical equipment program are also applicable to mechanical equipment.

(4) Identification of non-metallic material capabilities.

(5) Evaluation of environmental effects.

Staff Assessment:

There is a marked difference in the staff's handling of EQ for electrical equipment as compared to mechanical equipment. While the peer review comments indicate that specific guidance has been established for EQ of mechanical equipment, it was not done in the same prescriptive manner as was thought to be necessary for electrical equipment and it appears that the same level of effort has not been placed on assuring that EQ of mechanical equipment is adequate for operating reactors. It appears that the NRC staff has established a less rigorous qualification standard for mechanical equipment and focused staff attention is necessary to assure that mechanical equipment is adequately qualified. Specific guidance in this regard should be established and promulgated to the industry. An approach different from what was required for EQ of electrical equipment (e.g., prescriptive regulation, detailed program review, and confirmatory on-site inspection) should be fully justified.

3. Under the current requirements, active and passive EQ equipment are lumped together in the development of performance requirements, design requirements, maintenance programs, and safety priorities, which may not be entirely appropriate.

Peer Review Comments:

a. I am not sure of the basis for this issue.

b. This was done for conservatism.

c. I agree. A few utilities make the distinction. This is a good example of where the utility must address required service function, not just point at the vendor.

d. No opinion (I am not sure what the issue is here). Safety functional performance of an equipment is defined taking into account its interfaces with passive items such as cables, terminations etc. During the qualification process, this functional capability is demonstrated either in a single test program or through multiple tests and analysis programs. The concern regarding safety priorities, and the maintenance area needs to be better defined. The safety priority of the protective/safety function performed by an equipment item governs the safety priorities for its interfaces, be they passive or active. As for maintenance, to the extent there are maintenance attributes for passive items, they should have been, (and I know they generally are) addressed in a utility's maintenance program.

e. Active and passive equipment are important - "lumping" issue is not.

f. I am not clear how safety priorities are an issue.

g. Successful operation of passive equipment (cables, terminal blocks, breakers, etc.) is often necessary, permitting the operation of active equipment. Thus, it seems appropriate for qualification and documentation of its performance, maintenance, and safety priorities.

h. Merits analytical resolution (i.e., analysis of existing information is warranted to reach resolution).

i. The EQ requirement is that components (i.e. components within the scope of 10 CFR 50.49) must be able to perform their required functions when called upon for as long as required. This requirement applies to both active and passive components. Licensees have found and the NRC has accepted) various ways to demonstrate that equipment in their EQ programs meets this requirement. There is no specific requirement to lump or not lump together performance requirements, design requirements, maintenance program or safety priorities. If there are inappropriate lumping of requirements, specific identification and elaboration on such requirements are welcome.

Staff Assessment:

From a safety perspective, full advantage should be taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may exist on an ongoing basis. Implementation of the maintenance rule will help to resolve this problem for active components, and the staff should initiate action to include electrical equipment within the scope of the maintenance rule to better address this concern. Also, given the advances that have been made in our understanding of EQ over the past 25 years, cost-effective improvements may be possible in the application of EQ requirements and the NRC staff should be receptive to proposed changes in the EQ methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

4. EQ requirements seem unreasonable for equipment located outside containment and exposed to short-term steam conditions and/or radiation-only harsh environments when considering the low core damage contribution of this equipment compared to critical components that are located inside containment. PRA implications/EQ screening criteria may be helpful in establishing whether or not and to what extent EQ is truly necessary for a given component.

Peer Review Comments:

a. EQ requirements for equipment located outside containment that is relied upon to function during and/or following a DBE are reasonable since the qualification requirements for those components do not include harsher environments than they will see

during the event. If the equipment is not relied upon, then it should not be in the EQ program. PRA can be used to assess the level of reliance but this should be done with caution and should include a review to ensure that the plant's safety analysis remains valid.

b. Maybe the criteria for master-listing should be revisited. In general, I don't feel that qualification for outside containment is onerous.

c. I agree. This is long overdue and a concerted effort has the potential to narrow the scope of equipment included in EQ programs. This is true for both in-containment and out-of-containment equipment populations. Also, note that just because an equipment item is located in an area outside the containment, and that it may only be exposed to short duration environmental extremes, it cannot be automatically concluded that it doesn't have to be qualified. Some equipment/components have the potential to experience common cause failures even under these conditions.

Further, I believe that we do now have sufficient real world experience data to permit a meaningful assessment of equipment failure rates in nuclear plant environments. This should be used when performing the PRA.

d. This is a valid issue; PRA is a good screening tool.

e. The philosophy utilized to date has been for equipment needing to function or fail safe in harsh environments, that it be qualified to its harsh environment. The qualification almost always includes some testing to assure its operability in the harsh environment, even if this environment is relatively low steam conditions or radiation only. Many types of equipment do have problems with these less severe DBAs. For instance, the steam causes condensation and many types of equipment have experienced problems such as switchgear, MCCs, and hydrogen recombiners. The increased radiation levels on the order of 1E4 RADs and above do cause problems for integrated circuits (ICs). Some IC's, such as CMOS devices are susceptible to radiation levels of 1E3 to 1E4 RADs. Some newer devices, such as NMOS devices (found in computer chips) have experienced failures in the 100's to 3000 RADs range.

f. Merits analytical resolution. It will be useful for the NRC to establish its position on the applicability of PRAs to equipment qualification. Also, there is a need to evaluate the use of PRAs to justify short LOCA tests.

g. First of all, a properly developed EQ program includes <u>only</u> those items of equipment (i.e. equipment within the scope of 10 CFR 50.49) that are relied upon to remain functional during and following design basis events. Therefore, since the program includes only those items that <u>must</u> function, PRA does not seem to

have a role at this point. The EQ requirement for these items of equipment is that they must be able to perform their required functions when called upon for as long as required. It is not unreasonable, for example, for applications where a component is required to be qualified for service inside containment and a similar component is required to be qualified for service conditions outside containment (where the potential harsh environment is significantly less severe), if the licensee chooses to use the same component outside as is used inside containment. Under these circumstances, licensees are not required to use the same component; however, using the same component may provide desired flexibility. Again, this is not unreasonable, it is the licensee's choice and it provides desired flexibility.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience, PRA insights, and plant experience, some improvements in the EQ requirements may be possible and of benefit to the industry. The staff should be receptive to proposed changes in the EQ methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

5. PRA studies indicate that EQ Master Lists may need to be updated to include additional equipment.

Peer Review Comments:

a. If true, the EQ lists should be updated.

b. This is valid, but additional equipment to be added is probably non-safety related.

c. Merits analytical resolution (i.e., analyze existing information to reach resolution). Also see comment 4.f (above).

d. What PRA studies? Please identify the indicated studies, and provide copies for NRC staff information. It is the licensees' responsibility to update EQ master lists as new information becomes available.

Staff Assessment:

Additions to the EQ Master List would only be appropriate if the benefit to safety is significant as defined by the IPE initiative. In this regard, the staff should assure that EQ shortcomings would in fact be addressed under the IPE program. Beyond this, the use of PRA for EQ applications may be of significant value to the industry in better focusing EQ requirements and the expenditure of resources. The staff should be receptive to proposed uses of PRA with regard to EQ that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified and in keeping with the Commission's policy on the use of PRA.

6. The single failure criteria has not been applied consistently relative to EQ. For example:

Peer Review Comments:

a. I don't think that plant design bases are consistent.

b. May be true, but so what! Each issue should be evaluated separately.

- The single failure criteria was not imposed for qualification of cold shutdown equipment (i.e., IEB 79-01, Supplement 3, only required one train of cold shutdown equipment to be qualified).

Peer Review Comments:

a. The concern regarding IEB 79-01B supplement 3 clarification is perhaps a legitimate one in that there is no documented basis that I am aware of as to why this exception is acceptable for older plants. As one of the parties to the many NRC and Industry discussions on this subject during the early 1980s, my recollection is that:

  - For some older plants, requiring the environmental qualification of the total population of the cold shutdown equipment would have been impractical to implement with the as-licensed system configurations, and

  - The intent was to limit the environmental qualification requirements to the system/equipment complement in one (complete) path required to achieve a cold shutdown condition rather than applying it to all equipment called for in the emergency procedures.

  Perhaps, a better documentation of the basis for this will help clarify why this is considered consistent application of the single failure design criteria.

b. Qualifying one train of cold shutdown equipment will insure that a single failure will not occur. However, 10 CFR 50.49 superseded IEB 79-01 and its supplements; it requires qualifying a path to safe shutdown. Please note that qualification in the context of 10 CFR 50.49 assures that a single failure will not occur, and by doing so the single failure criteria is imposed.

- With regard to the "superheat effects" of a MSLB, the staff's resolution of TAP A-21 failed to include single failure considerations.

Peer Review Comments:

a. Single failure was considered; it was factored into the mass and energy releases from MSLB. There is no "additional" single failure considerations from "superheat effects."

b. The issue regarding MSLB superheat effects analysis not including single failure considerations, if true, is an accident analysis issue, NOT an EQ issue.

- As stated in Regulatory Guide 1.89, the purpose of environmental qualification is to avoid "common-cause" failures. Given this, it is not clear why it is necessary to qualify equipment to protect against single failures.

Peer Review Comments:

a. I agree. However, what's the difference in terms of type testing? The tests show that a component can perform.

b. The ability to withstand a single failure is one of the elements of defense-in-depth applied in the design of safety systems. The purpose of EQ may be summed up as preserving the defense-in-depth. In other words, it is to identify and eliminate the potential for common cause failures that may challenge the defense-in-depth, specifically in accident environments. That means EQ may not even focus on (i.e., we do not intentionally go looking for) the potential for common cause failures if the equipment is operated only under normal environments at all times. As such, sing' failure fall into the category of random failures. Therefore, it is not clear why consistent application of single failure is an EQ issue. In my opinion, if there is a concern regarding single failure application, it should be treated as a design basis issue.

c. The purpose of EQ is to demonstrate that the safety related equipment does not have a "common cause failure" which could take out redundant sets of the same equipment. Qualification does not assure that a random failure would not occur. A random failure, however, should have very low probability of taking out redundant equipment. If the probability is high, then it is probably a "common cause." In order to demonstrate that equipment does not have a "common cause failure", then all failures during qualification and in service should be analyzed to determine the root cause. Once the root cause is known, then the judgment as to the cause being random or common mode can be made.

Any failure in qualification, or in service, which is common cause, would render the qualification suspect until it can be corrected. The area of assuring that failures seen in service are not common cause would seem to provide the best payback for safety.

d. Merits analytical resolution (i.e., analyze existing information to reach resolution). Although single failures are assumed to occur independently of any other failures, it is possible that the failure is the same as a failure that can result from a common cause. Unless I misunderstand the statement, its logical implication might be that qualification is not necessary at all.

e. Perhaps a better choice of words for RG 1.89 would have been "to insure that common-cause failures do not occur".

Staff Assessment:

The staff should determine to what extent single failure considerations are applicable to EQ, and assure that qualification of cold shutdown equipment and resolution of TAP A-21 is consistent with the position that is established.

7. The adequacy of safe shutdown capability with regard to EQ has not been rigorously addressed (e.g., hot shutdown vs. cold shutdown capability; single failure requirements, etc.).

Peer Review Comments:

a. I believe that this was addressed.

b. I disagree. Given that the EQ master list called for in 10 CFR 50.49 is established taking into account the various accidents, the resulting environments, and the complement of systems and equipment required for each of those accidents, I fail to understand the basis for this statement.

c. Non-issue. Safe shutdown is evaluated through many paths: Appendix R, PRA, FSAR, etc. EQ master lists take this into consideration.

d. Merits analytical resolution (i.e., analyze existing information to reach resolution).

e. The EQ rule (i.e., 10 CFR 50.49) requires qualification of safe shutdown equipment. If this statement is suggesting that this requirement is not adequate, than this issue should be discussed in more detail with the NRC staff and management.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments may be warranted. The staff should determine to what extent qualification of equipment for achieving cold shutdown is truly necessary irrespective of licensing basis, to assure that a safety concern does not exist (for those plants that are not required to qualify equipment necessary to achieve a cold shutdown condition) and document the basis for the position that is established. The NRC staff should also be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

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[1] This includes equipment required to remain functional and those whose failure can affect the safety functional capability of other safety-related equipment.

B. Better definition of which instruments are required to be qualified is needed, with supporting basis.

Peer Review Comments:

a. I agree to the extent it relates to the need for a PRA based redefinition. If the current deterministic evaluation is what is intended in this statement, I must question why? Are we then saying:

- that RG 1.97 is inadequate? If so, it is not an EQ issue, but may be an accident analysis and emergency operating procedures issue.
- that the criteria enumerated in 10 CFR 50.49 for establishing an EQ list is incomplete. If so, under what condition or accident scenario(s)?

b. Non-issue. Criticality of instruments is factored into selection for MEL.

c. EQ list should be adequate to determine which equipment should be qualified.

d. In response to 79-01B, utilities were required to document the safety related functions for safe shutdown. Once the equipment was identified and it was determined that it was located in a harsh environment, in order to assure its function, that equipment was required to be qualified. I witnessed the NRC EQ audit team review of these analyses during many audits. Thus, I'm confident that the utilities have this documentation and supporting basis. The design basis reconstitution process that many utilities undertook was partly involved at upgrading these analyses.

e. Merits analytical resolution (i.e., analyze existing information to reach resolution).

f. All equipment, including instruments, required to be qualified is discussed in 10 CFR 50.49 (b1), (b2), and (b3). This requirement is written in a manner that includes the flexibility that is necessary to recognize the differences between the many plants that is required to comply with all the Commission's regulations. It is the responsibility of each licensee to determine exactly what equipment fits into each of the three categories.

Staff Assessment:

Based on the staff's review under EQ-1AP Action Item 3.e [10], it appears that the instrumentation that was required to be qualified was well defined. However, given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive

to proposed changes in the instrumentation requirements that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

9. Safety-related equipment located in mild environments that experience severe environmental conditions due to the operating condition, such as self-heating from being continually energized, may not be adequately qualified.

Peer Review Comments:

a. May be true, but probably a rare occurrence. Design requirements for safety-related equipment include requirements for assessing environmental effects such as self heating.

b. Such equipment should be covered under non-EQ design range testing.

c. I disagree. 10 CFR 50.49 does not require qualification of mild-environment equipment. At present, environmental qualification is focussed only on demonstrating the inherent functional capability of harsh-environment equipment, particularly in accident environments. For mild-environment equipment, implementing appropriate surveillance, maintenance, and failure analysis to address degradation due to normal operational and service environments is believed to be adequate. This position has been accepted by the NRC in the past in several meetings with the industry. What has changed now? If equipment operating and failure experience suggests that maintenance programs are inadequate, then it should be pursued as an oversight issue related to the maintenance and surveillance of mild-environment equipment. Perhaps, a systematic study of all equipment failures in the industry can shed light on this subject. In any event, I am not clear why this is an EQ issue.

   However, it should be noted that one can make a seismic qualification issue of this, if indeed it can be shown that operating/failure experience shows a potential for reduced seismic functional capability.

d. This is a valid issue. Focus has been on harsh environment because of 50.49.

e. I am not clear whether this is an EQ issue.

f. Safety related equipment in mild but not benign environments, do not now have to be qualified. Rigorous qualification and maintenance programs to identify and document qualification are probably not cost effective because much time would be spent on reviewing paper work. A more cost effective approach, which would increase safety assurances, would be to encourage the utilization of more modern, sophisticated non-intrusive test equipment to monitor the condition of equipment. All electrical

equipment has heat as a by product. In the generation of NPAR Report NUREG/CR-5762, it was noted that infrared thermography was a new, modern tool for measuring non-intrusively, the temperature of equipment. This tool and others, such as vibration signatures, have been shown to be sensitive to age related degradation.

The sensitivity to age related degradation and the non-intrusive attribute provide a much more economical method of detecting degradation before equipment failure. It is condition monitoring, which focuses on looking at the hardware in its normal state. The proper focus should be at looking at hardware instead of paper. Thus, the encouragement of equipment condition monitoring would seem to have significant cost and safety impact.

g. More NRC oversight may be needed to assure compliance with EQ requirements.

h. In accordance with the Statement of Consideration for the final EQ rule dated January 21, 1983: The final rule does not cover the electric equipment located in a mild environment. The Commission has concluded that the general quality and surveillance requirements applicable to electric equipment as a result of other commission regulations including 10 CFR Part 50, Appendix B (see for example Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operation)," Revision 3) are sufficient to ensure adequate performance of electric equipment important to safety located in mild environments.

Staff Assessment:

From a safety perspective, full advantage should be taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may exist on an ongoing basis. Implementation of the maintenance rule will help to resolve this problem for active components, and the staff should initiate action to include electrical equipment within the scope of the maintenance rule to better address concerns such as this one.

Summary

Based on the staff's review of scope/applicability issues, the following recommendations were made:

a. Although EQ research on some components may not have been as extensive as cable research, additional research should not be performed unless: (a) it is based on a well defined need for further research, (b) there is a good likelihood that the desired information will be obtained, and (c) the cost of the research is justified in terms of the expected benefits to public health and safety.

b. Full advantage should be taken of operating plant experience and PRA information, equipment performance, condition and environment

monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may exist on an ongoing basis. In order to facilitate this effort, the staff should initiate action to include electrical equipment within the scope of the maintenance rule.

c. 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 is required 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.

d. The NRC staff should assure that significant EQ shortcomings will be addressed under the IPE initiative.

e. The NRC staff should determine to what extent single failure considerations are applicable to EQ, and assure that qualification of cold shutdown equipment and resolution of TAP A-21 is consistent with the position that is established.

f. The staff should determine to what extent qualification of equipment for achieving cold shutdown is truly necessary irrespective of licensing basis 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.

g. Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, adjustments in existing EQ requirements may be possible and of substantial benefit to the industry. For example, it may be possible to better focus EQ requirements by using PRA techniques, and better definition of the role that single failure plays relative to EQ could result in better directed qualification requirements. The NRC staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically acceptable.

The NRC staff did not consider any of the scope/applicability issues to be an immediate safety problem.

B. EQ Methodology

1. Many facets of the methodology for establishing initial qualification of equipment have not been adequately addressed and justified on a rigorous, technical level, including (for example):

Peer Review Comments:

a. The bullets that follow are too general for comment. I thought that these points (other than cost) were covered for properly qualified equipment.

b. The main consideration is that the methodology selected will increase plant safety.

c. Issues such as dose rate effects, oxygen diffusion considerations, mandrel bend test requirements, etc., are EQ issues that are now, and have been for some time, the subject of many discussions and require engineering solutions acceptable to both industry and the NRC. To date, these issues have not prevented EQ programs from being developed by industry and approved by the NRC. We should continue to work to resolve these issues in a way acceptable to all involved.

- use of test data versus other methods such as operating experience and analytical techniques (for example, extrapolation of data or operating experience, if adequately justified, may be well suited for EQ applications);

Peer Review Comments:

a. I disagree. Why is this an issue since the NRC has already outruled (defacto) anything but test as an acceptable method for demonstrating qualification of harsh-environment equipment? Delete this from further consideration because:

- For all practical purposes, establishing qualification is complete for plants that are operating.
- We have very limited experience on the performance of equipment under accident conditions to draw from.
- It is impractical if not impossible, to analyze equipment performance capability under accident conditions.

Thus, preference for test over other methods for environmental qualification is justifiable.

For seismic qualification, it is prudent to examine a greater level of use of operating experience, and this is being addressed by IEEE.

b. The key words are "adequately justified." A number of licensees unsuccessfully attempted to use data extrapolation for

qualification where the data presented did not represent the formulation of the component to be tested or the source of the data did not identify that it was obtained in a manner that duplicated the expected DBE environment. For example, cables manufactured by the same manufacturer using generic terms for its materials (e.g., butyl) can use different formulations of the material and data for materials used in taped splices can look acceptable unless you recognize that the adhesive can fail in a harsh environment that includes submergence in water. If adequately justified, the use of such data is acceptable.

c. This is a valid issue.

d. The DOR Guidelines had some good words requiring tests for harsh pressure-temperature-steam environments. How do you extrapolate normal operation to conditions that by definition are more severe (e.g., you can test water forever at 211°F and be ignorant about what happens at 213°F)?

e. Some physical data will always be required. Operating experience and analysis would, by themselves, not be acceptable.

f. IEEE 323-74 allows qualification by type testing, operating experience, and analysis. NRC made it clear via workshops in the 1980's, audits, and correspondence that the preferred method was type testing. To qualify by operating experience, equipment would have to have documentation showing that it has experienced and operated properly in a DBA. Since only TMI has experienced a DBA, very few equipment items have been qualified for harsh environments based on operating experience. Analysis only is also very difficult to have demonstrated, since there are no formulas to reliably predict operation of any type of equipment in a harsh environment. Thus, little effort should be placed on addressing techniques which are not normally used. A stronger policy statement than the one in RG 1.89 may be considered to discourage the other less utilized methods of qualification.

g. Merits analytical resolution; industry responsibility. All three methods and combinations of them are acceptable with justification. IEEE has initiated an effort to consider preparation of a standard that will address the use of operating experience in qualification.

h. I think type tests should be the basis for qualification. Other methods of qualification such as analysis and operating experience are extremely limited in application and have little practical value.

i. Under what circumstances is test data not appropriate? If the intent of this question is to suggest that test data need not always be required, than I refer you to 10 CFR 50.49 (F)(3) where experience with identical or similar equipment under similar conditions with a supporting analysis to show that the equipment

to be qualified is acceptable. In addition, NRC staff experience over the years indicates that there is no basis to support analysis only or extrapolation of data, and what can operating experience tell you about the ability of a component to survive a LOCA? Finally, what is adequate justification?

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience, PRA insights, and operating plant experience, some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- the environmental conditions (e.g. temperature, pressure, radiation, etc.) that are postulated for both inside and outside containment;

Peer Review Comments:

a. I disagree. I am not clear what the issue is here. Haven't we already established the framework for a consistent set of methods for deriving the environments in both DOR and NUREG documents? What is the inconsistency that still needs better technical justification? If the concern relates to minimizing the level of conservatism, then it should be a Regulatory Requirements Reduction issue rather than an EQ Issue.

b. This is a valid issue.

c. This is not a methodology issue.

d. The environmental conditions postulated for inside and outside containment during a DBA probably are conservative. Plants have used computerized modeling techniques to predict the heat and mass transfer. There have been a few tests to aid in developing these models, such as the FTIR tests and GE's full scale torus testing. Some utilities have done some special tests to aid in predicting the environment. In many cases, the postulated DBA is in conflict with natural steam phenomenon. For instance, most DBA curves show superheated steam, i.e. 340 °F and 60 psig (at saturated conditions the pressure would be over 100 psig). Then the curves show chemical spray coming on and the temperature and pressure would be the same as before the spray.

In actual testing, the spray causes the steam conditions to go into saturation, which immediately drops the temperature. Typical postulated curves don't show this phenomenon.

Additionally, most postulated DBA's outside of containment show instantaneous temperatures above 212 °F being distributed to many areas in the reactor building which are not pressurized. Natural condensation, deflection of steam off of the walls, around corners

and on equipment would cause condensation and a reduction in steam temperatures. Additionally, cabinets with louvers or few openings would contain trapped air, which would have to be displaced by the steam and thus a natural thermal delay results. Research into the steam phenomenon would most likely reduce the predicted severity of steam line breaks outside containment and in compartmentalized containments.

Radiation is also predicted to occur instantaneously. The levels of radiation and the instantaneous release are probably overly predicted.

e. Industry responsibility; this is best resolved by the industry.

Staff Assessment:

In general, the environmental conditions that were required for EQ were based on accident analyses that included additional margin and are believed to be conservative. However, given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be necessary. The staff should assure that information in this regard is catalogued and well understood, and made available to the industry. It is the licensees' responsibility to make use of new generic information, as well as plant-specific information, and to make adjustments to their EQ programs when such action is warranted. This does not necessarily mean that EQ programs must always become more restrictive; new information might very well support a relaxation in program requirements.

- age conditioning;

Peer Review Comments:

a. I agree, it is well known and accepted that the methods established were the "best practical" given the [then] state of the technology. Holes have been identified in both the technology and its application. I am also of the opinion that eventually we need to get out of the frame of mind wherein we assign a "qualified life" based on simulated aging tests and then treat it as sacrosanct, and pencil whip it to increasingly higher levels of precision depending upon who does the math using what information.

I believe that the true answer lies in verifying the correlation between real world aging vs. simulated aging. In other words, condition monitoring.

b. This is a valid issue.

c. Considerable research has been dedicated to age conditioning. Prior to Sandia's research, NRC was presented with information on how Arrhenius theory formed the basis of the Underwriter Laboratory Specification UL 746B and IEEE Stds. 99 and 101.

Additionally, Arrhenius theory is the basis for reliability calculations in military, NASA and the semiconductor industry.

d. Merits analytical resolution. The level of past and ongoing experimental research on age conditioning is consistent with the importance of this issue. However, careful evaluation is needed to assure that future research is directed to investigations of the highest priority that have the prospect of success in a reasonable time. More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements to resolve the problem of demonstrating a meaningful qualified life.

Staff Assessment:

Preconditioning of equipment is necessary as a fundamental part of initial qualification testing, and the current methodology is thought to be conservative. The amount of preconditioning that is truly necessary to establish qualification is subject to debate, however; and given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some changes may be appropriate. The staff should be receptive to proposed changes in the methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- margins (in general) and use of "excess margin" to justify shortened post-accident test duration during DOR LOCA testing;

Peer Review Comments:

a. Margins in general: I disagree. I don't think this needs work unless one wants to go after establishing a basis for possible relaxation of current IEEE requirements. The current practice of using IEEE-323 type margins for test parameters is justifiable and represents a practical engineering approach to accommodate some uncertainties such as manufacturing variations, and should be continued.

"Excess margin" used for justifying short duration tests: this issue deserves some attention by performing a set of very focused LOCA tests to determine if the results support the method in which margins or conservatism in the test parameters were used to justify shorter test durations in some older plants. Many types of analysis techniques have been used. One should examine the validity of the extrapolation of Arrhenius parameters to temperature ranges far beyond where they were experimentally established. In my opinion, this can only be resolved by testing.

b. This is a valid issue, but it is being addressed via the current NRC research program plans relative to EQ.

c. Determine whether the test is modeled adequately.

d. Margins were required to be documented for all plants, regardless of EQ licensing basis.

e. Merits analytical resolution; merits experimental research. The correlation between margin and its contribution to safety assurance is not likely to be established quantitatively with any reasonable amount of research; and it will therefore remain largely a matter of engineering judgment. However, if there is a serious question concerning the justification for the use of excess margin to compensate for short DOR LOCA tests, I doubt the question can be resolved simply by engineering judgment. It might be necessary to repeat some tests using the current LOCA testing practice and to compare the outcome with that of the DOR tests.

Staff Assessment:

Margins (in general) are thought to be conservative. However, given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. Also, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, it may be appropriate to relax some requirements. The staff should be receptive to proposed changes in the margin requirements that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

With regard to the use of "excess margin" to justify the short duration LOCA tests of the DOR Guidelines plants, this may be a valid concern and it should be reviewed further by the staff.

- the test sequence and test duration, including post-accident operating times;

Peer Review Comments:

a. This should not be an issue after all the research that has been conducted to date. The current literature review [being completed under contract to the NRC] should put an end to this once and for all.

   However, one can make a case for a shortened post-accident duration for test purposes, and consistency in this regard. A study focused on this narrow question that systematically evaluates each accident scenario for the time required to achieve cold shutdown (or some other acceptable intermediate plant condition) is desirable.

b. This is a valid issue.

c. Merits analytical resolution and experimental research. As for test duration, there is a need to evaluate the use of PRAs to justify short LOCA tests.

Staff Assessment:

Research is good to a point, but there are limitations to what can be accomplished. The results of past research efforts should be catalogued and the information should be well understood and used in addressing issues such as this one. Any further research should: a) be based on a well defined need for additional information, b) be pursued only if there is a good likelihood that the desired information will be obtained, and c) be pursued only if the cost of research is justified in terms of the expected benefit to public health and safety.

With regard to post-accident operating times, there appears to be confusion and inconsistency. Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustment to the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in the methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- mandrel bend test requirements:

Peer Review Comments:

a. I agree. The question is whether or not they are required. My understanding is that the writers of IEEE-383 intended it to assure that vibratory and shock forces from a seismic event are properly accounted for in the environmental qualification process. Many in the industry are of the opinion that these requirements may be too conservative. One should reserve judgement on this issue because, contrary to what many believe, there are many installations (e.g., free hanging cable at termination points such as those with connectors, and cables in flex conduits at termination points) in plants wherein cables will be subject to such vibratory and shock forces during a seismic event. In an aged condition, these installations may be more vulnerable to a common cause failure. There are a few examples of failures wherein motor lead wires grounded to short caused by wire insulation (in aged and brittle condition) falling off from motor-starting forces. But, such forces are much greater than those from a seismic event.

   Perhaps, a study and some tests to determine if aged cable jackets and insulations can withstand these forces, can answer these questions. This should be a low priority item. Pending completion of such a study, it is prudent to continue current practices.

b. This is a valid issue; needs to be addressed.

c. This test bounds the expected worst case dynamic/static forces that a cable may be exposed to in the field yet which are not reproducible in a test chamber. If another more realistic method is available, it should be proposed by IEEE.

d. Merits analytical resolution; merits experimental research. There is substantial agreement that post-LOCA mandrel bend tests are too severe; and in some recent cable EQ programs, these tests have been omitted. However, if they are omitted, part of their original purpose, i.e., to account for vibration and seismic effects, would have to be addressed.

e. Please provide an acceptable alternative.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- synergistic effects;

Peer Review Comments:

a. After all the tests by the industry, and by Sandia and others, it is hard to believe that this is still an issue.

b. This is not a valid issue; sufficient research has been done.

c. The synergistic effects of sequence have been addressed for many years with most test programs using the sequence of radiation exposure prior to thermal aging.

d. Merits analytical resolution; merits experimental research. It would be useful for the NRC to update its position to account for the research conducted during the last decade. The research results are difficult to generalize and are somewhat inconclusive. There is some evidence that the degradation of equipment during LOCA conditions may overshadow aging degradation to such an extent that synergistic aging effects should not be a major concern.

Staff Assessment:

To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance. However, given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. The NRC staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- dose rate effects:

Peer Review Comments:

a. After all the tests by the industry, and by Sandia and others, it is hard to believe that this is still an issue.

b. Not valid; sufficient research has been done.

c. Dose rate effects are considered to be second order effects, more than adequately accounted for by using the very high radiation total doses typical of qualification.

d. Merits analytical resolution; merits experimental research. It would be useful for the NRC to update its position to account for the research conducted during the last decade. The research results are difficult to generalize and are somewhat inconclusive. There is some evidence that the degradation of equipment during LOCA conditions may overshadow aging degradation to such an extent that dose rate effects should not be a major concern.

Staff Assessment:

See the staff assessment re: synergistic effects (above).

- oxygen diffusion considerations; and

Peer Review Comments:

a. This is a valid issue.

b. In my opinion oxygen diffusion effects are second order effects because 1) many plants use inerted containment, for which EQ credit has not generally been given, 2) oxygen is used in temperature and LOCA chambers, and 3) root cause analyses have not shown oxygen diffusion to be a source of differences in anticipated and expected results.

c. Merits analytical resolution; merits experimental research. It would be useful for the NRC to update its position to account for the research conducted during the last decade. The research results are difficult to generalize and are somewhat inconclusive. There is some evidence that the degradation of equipment during LOCA conditions may overshadow aging degradation to such an extent that oxygen diffusion effects should not be a major concern. Also, the oxygen diffusion effects predicted by research on insulation materials were not always evident in later cable research.

d. What realistic assumption are being referred to? It is realistic assumptions that requires the consideration of oxygen diffus'on. The assumptions being alluded to should be provided for review and discussion.

Staff Assessment:

See the staff assessment re: synergistic effects (above).

- cost.

Peer Review Comments:

a. This is truly an issue, especially in the current competitive utility industry environment. This should be addressed perhaps by keeping an open mind to review and where practical accept innovative alternatives proposed by the industry to address EQ. An example of this already being implemented is the MEQ exemption request. Another area worth pursuing from a regulatory aspect is to remove the requirements to establish and track "Qualified Life," and substituting it with greater reliance on equipment operational reliability analysis, reliability centered maintenance and condition monitoring/assessment. From the regulator's perspective, this will require a study to establish a framework for implementation. Such an approach will also go a long way toward addressing EQ related license renewal considerations. I might also note that this approach will be consistent with those of Germany and France.

   Also, the industry needs to do its part by doing more joint group work on qualifying new equipment, EQ problem resolution, and standardizing systems/equipment for use in the nuclear industry at least at plant vintage levels. This is what the French do and we can learn from their experience.

b. This is not an EQ issue; do value impact.

c. The concern is not clear; the specific cost problem(s) should be identified.

Staff Assessment:

Cost is definitely an issue for the industry when it comes to EQ, and there may be acceptable cost-cutting measures that can be taken. While the staff should be receptive to reducing costs that are imposed on the industry, the onus is on the industry to propose and justify lower cost alternatives.

The following problem statements expand on certain aspects of this issue:

- Different EQ standards were imposed (i.e., DOR Guidelines, NUREG-0588 Category I, and NUREG-0588 Category II) without supporting technical justification as to: (a) why more rigorous standards were warranted, and (b) why "progressively less strict standards" were adequate for the older plants (e.g., older plant equipment qualification is not as rigorous as NUREG-0588 since the components have been qualified without aging, margins, or considering synergistic effects).

Peer Review Comments:

a. There may be some instances where equipment qualified under DOR

requirements would not have passed Category I requirements. This is an issue that should be evaluated by RES in regards to life extension since the effects of in-situ aging past 40 year plant operation must be addressed (particularly for cables).

b. Somehow, I thought that there was "supporting technical justification."

c. This is being addressed by the current NRC research plan.

d. Different EQ standards were applied because of licensing differences between vintages of plants. The attempt was made to assure that technically each was effectively the same. When 10 CFR 50.49 was issued and licensees were required to meet the rule, the major impact was to add some items to be qualified.

The EQ contentions at Shoreham (NUREG-0588 Category II plant) were largely based on the differences in EQ requirements for different vintage plants. The contention was that the EQ program at Shoreham was deficient because of several items including the concern that equipment was qualified by grandfathering to older, less stringent standards and that there was inadequate demonstration that all safety related equipment was properly qualified to meet aging and other life requirements.

The testimony of NRC Staff James E. Kenney and Vincent S. Noonan concluded that "The new legal requirements [10 CFR 50.49] are based in large part on the previous requirements and are not expected to significantly modify the existing [EQ] program." The ASLB found in favor of LILCO.

At the time of DOR Guidelines and 10 CFR 50.49 promulgation, it was the consensus that 1) all plants had equal technical requirements to demonstrate by testing that equipment could operate properly during and following DBA's and that methods allowed to address aging were the main differences, 2) certain equipment such as motors, cables, and MOV actuators were qualified using pre-aging, regardless of the plant's DOR, NUREG-0588 Cat I or Cat II licensing basis.

My opinion is that the known synergisms, such as dose rate and sequence are second order effects. The changes in properties caused by these second order effects are insignificant when compared to the degradation caused by using conservative testing conditions. Sandia's Mark Jacobus agreed with this and so stated it in NUREG/CP-0135, p. 2-16.

e. Merits analytical resolution; this is a valid concern and one that has been recognized by the Commission. Since the NRC is already investigating this issue, no further comment is offered.

f. There are basically two standards, simply because the DOR Guidelines and NUREG-0588 Category II are quite similar.

Therefore, we have NUREC-0588 Categories I and II. NUREG-0588 Category I is the standard which all plants are supposed to eventually reach. The NRC staff was supposed to develop technical justification for the progressively less strict standards for older plants. However, to date that technical justification has not been developed.

Staff Assessment:

Although different EQ standards were imposed (i.e., DOR Guidelines, NUREG-0588, Cat. I, and NUREG-0588, Cat. II), each was intended to establish a reasonable level of assurance that equipment would function when needed during a postulated event, given that some plants were already operating while others were in various stages of construction. It has been argued that one method is more rigorous than another, but this becomes irrelevant if one accepts that each method is sufficient to establish qualification for some initial, prolonged period of time. The critical question becomes one of how long the qualification is good for. None of the qualification methods has been successful in establishing a "qualified life" with any degree of certainty and all must be supplemented with operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information on an ongoing basis in order to provide assurance of continued qualification over the life of the plant (this is discussed more fully in the staff assessment of the fourth problem statement concerning "state of the art capabilities" and determination of a "qualified life, below).

The current version of IEEE 323 may be better suited for demonstrating EQ than the 1974 version since much more information and experience are available now than there was when IEEE 323-74 was endorsed by the staff.

Peer Review Comments:

a. Do the 115 or so operating plants, and their vendors, meet the new IEEE-323 standard?

b. This is a valid issue.

c. The current version of IEEE-323 is not different than the 1974 version with respect to qualification practices and there is not any further knowledge provided in the standard. Thus endorsement of newer versions of IEEE-323 is unnecessary.

d. Merits analytical resolution; IEEE claims that the two versions are equivalent, but not all parties agree that such is the case. On various occasions, the NRC has communicated its position on this matter orally; it would be helpful if the position were documented.

e. This is totally false and would only be made by someone totally unfamiliar with EQ. What is the basis for such a statement? How is the current version better suited to accomplish the intended

goal of environmental qualification? Has the person who posed this question read both versions? If so, what is the basis for this statement? If not, please read the two documents.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustment in the requirements may be possible and beneficial to the industry. Also, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, some relaxation of the more rigorous requirements may be warranted. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

Given the Regulatory Requirements Review Committee and the NRC staff view that backfitting the IEEE 323-74 requirements would provide "...a small, unquantifiable increase in the level of assurance that equipment is qualified as compared to the significant costs that would be involved...." IEEE 323-74 may not be warranted or sufficiently justified as a necessary qualification standard for power reactors, regardless of when the Construction Permit Safety Evaluation Report was issued.

Peer Review Comments:

a. I agree, except in the case of life extension.

b. Maybe a new cost-benefit analysis is needed. Cost impact is certainly greater for existing plants.

c. Non-technical issue; outside the scope of research.

d. Backfitting to IEEE 323-1974 in my opinion is unnecessary because 1) there is little equipment that has not already been upgraded by new testing including aging, 2) as equipment is replaced, new qualification programs are being performed to 10 CFR 50.49, 3) Even DOR Guidelines plants have substantial percentages of their safety related equipment qualified using aging. Increased concentration on knowing equipment's condition and analyzing component failure root causes will lead to necessary feed back and corrective actions.

e. The construction Permit SER date was simply a way to separate operating plants and those that had already purchased significant amounts equipment at that time. The standard used to judge the capability of equipment to perform its function when it is call upon to do so is a safety issue, cost notwithstanding, and is supposed to represent minimal safety standards. That is why the Commission directed the NRC staff to provide technical justification for the progressively less strict standard for older plants.

Staff Assessment:

See the staff assessment of the previous two problem statements.

- Current "state of the art capabilities" may not be sufficiently developed to support existing EQ requirements, such as determination of a "qualified life;"

Peer Review Comments:

a. Unless the issue deals with life extension, I believe that qualified life has been adequately determined using existing technology.

b. ...and then again, in many cases, they may be. The concern is not specific enough to comment on. As written, it sounds shallow and superficial, as well as negative.

c. This is being addressed by the current NRC research plan.

d. Merits analytical resolution; the concern is valid and a concerted effort should be made to resolve the issue. The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service.

e. The state of the art "is" the state of the art. In the early 1980s when the current EQ rule was codified, it was concluded that in order to be assured that a specific piece of equipment can be relied upon to perform a required function at a given time, equipment had to have a qualified life. The method that was acceptable to both industry and the NRC was the Arrhenius Methodology of calculating qualified life. To date, a more acceptable method has not been developed.

f. Current "state of the art capabilities" are sufficiently developed to support the existing qualification requirements, including qualified life. This is really a two part answer. The first part addresses whether safety related equipment can operate properly during the DBA. The second part addresses the ability to simulate aging.

Operation of safety related equipment during the DBA, 1) is the most important part of environmental qualification, 2) was required of all plants (DOR and NUREG-0588), and 3) is the documented proof, through LOCA simulation tests that safety related equipment can perform its safety related function before, during and following a LOCA.

The NRC's and the nuclear industry's reliance on type testing for environmental qualification, rather than the other qualification options, such as analysis or operating experience, provides

substantial assurance that safety related equipment is qualified to the harsh environments.

Additionally, the vast majority of equipment was tested to enveloping, worst case accident profiles. The significance of this is that equipment may be subject to a line break during its installed life. That line break could be a small line break or a major double ended guillotine type break. It does not have to survive more than one. The qualification practice was to identify all of the potential line breaks for equipment in all locations in the plant. An enveloping temperature/pressure profile was then developed. Additionally, when equipment was being qualified for multiple plants, the worst case enveloping profiles were again enveloped. This practice assured that the significance of any actual DBA was less in severity to the enveloping requirement.

Thus, additional conservatism was added to the temperature, pressure, chemical spray, and radiation requirements. The successful completion of a DBA simulation test, of a representative sample, tested to this worst case enveloped profile, provides significant assurance that the equipment will operate as needed.

Additionally, for items such as cables, more than one test was most likely performed. For instance, in NUREG/CP-0135, page E-21, it was noted that one manufacturer's cable was tested to over 11 DBAs. The state of the art's ability to generate DBA Temperature/Pressure/Steam profiles is adequate since many test facilities in the US and throughout the world have this capability. Depending on the plant type, typical temperature and pressure maximums during DBA simulations are shown in Table 1.

Table 1

Plant Type	Typical Maximum Temperature of DBA	Typical Maximum Pressure of DBA
DOR Guidelines BWR	308 °F	50 psig
DOR Guidelines PWR	[illegible] F	35 psig
NUREG 0588 Cat I BWR	340 °F	50 psig
NUREG 0588 Cat I PWR	400 to 500 °F	60 psig

Additionally, Fort St. Vrain, a HTGR, had much of its equipment qualified by type tests for temperatures of 900 °F. Its cable was the same as many other plants.

All plants were required to document the qualification and NRC reviewed and audited these results.

Thus, the capability of safety related equipment to operate in a DBA has been adequately demonstrated using the state of the art of type testing. Strong support for testing comes from the theorem that one test is worth a thousand expert opinions.

The second part of the issue, simulating the deleterious affects of aging, has been performed using the state of the art. In the late 70's several studies were performed to determine the methods to be used to simulate aging. There were many who cited the lack of complete understanding of the aging process as an excuse to not move forward. However, many in the nuclear industry and the NRC saw the need to consider what was known about aging and how other industries had addressed the problem.

Three major industries had been utilizing techniques for many years to address aging and all three had basically been using Arrhenius Theory. These were: 1) Underwriters Laboratories for electrical insulation and plastics, using UL 746B; 2) the cable industry using IEEE 99 and 101, formerly ANSI A57; and 3) the military, NASA, and the semiconductor industry using reliability theory for life testing, which uses the Arrhenius equation to calculate life and failure rates.

Other aging theories had been proposed. The main reason that the nuclear industry accepted Arrhenius theory as an acceptable form of accelerated aging was 1) Arrhenius Theory had the most data behind it, 2) Arrhenius parameters for the most part had been developed by testing, and 3) Arrhenius Theory had been successfully used in military and NASA reliability efforts.

Arrhenius theory was the best theory available at the time when it was found to be acceptable in NUREG-0588. It continues to be the best and state of the art.

The accuracy of the qualified life determined by the Arrhenius equation has been a historic argument. In order to satisfy industry concerns on accuracy, several conservatisms are used in qualified life calculation assumptions. The most important are: 1) assumed operating temperature, 2) assumed material function, and 3) assumed interaction of multiple materials.

These conservatisms and assumptions were addressed as follows. The calculation for qualified life usually assumed that the materials of the safety-related equipment were at the maximum of the assumed temperature range and then heat rise and hot spot temperatures were added to this maximum temperature. Over the years, lessons learned, like determining the actual temperature rises of items containing significant heat sources, like solenoid valves, motors and transformers, were incorporated into the qualified life calculations.

Materials typically showed different rates of deterioration as to whether electrical or mechanical properties were being evaluated.

Thus the assumption as to whether the materials had an electrical function, mechanical function, or both, was an important assumption.

Lastly, few safety related pieces of equipment are simple enough to be comprised of only one material, such as most terminal blocks. When multiple materials are present, the material with the lowest activation energy was chosen for the qualified life calculation. This assures that all materials with a higher activation energy are aged to a longer qualified life. Additionally, with multiple materials, an implicit assumption is that the materials are compatible with each other and that new, synergistic reactions don't form.

Since much safety related equipment was qualified by accelerated aging, material incompatibility was discovered when it was present, because these items failed aging tests. Redesign and retesting were required in order to achieve qualification.

The results of much research in the 1980's has generated a lot of evidence that qualified lives may be conservative and little evidence exists that they may be overstated.

In my opinion, the accuracy of the qualified life calculation hinges dramatically on the underlying assumptions and that the state of the art is capable of acceptable accuracy, given that there is not an inherent flaw in the assumptions.

The most dramatic impact on qualified life would arise if the underlying assumptions were grossly different in actual service. Thus, new and continued focus should be on the safety related hardware's condition, which would provide the indication that an underlying assumption was flawed.

Equipment's condition can be ascertained with intrusive periodic testing, but this may cause more failures than leaving the equipment installed. Non-intrusive condition monitoring is preferred. New infrared thermography equipment makes it possible to monitor the temperature of individual pieces of equipment, non-intrusively. Thus, in addition to ambient temperatures, it is possible to obtain temperatures actually at and on each device. Knowing the temperature of each device allows the assumption of temperature exposure to be verified. Data taken to date indicates an equipment population which for the most part is operating at significantly lower temperatures than were originally assumed. For those devices for which the temperature was found to be higher than assumed, corrective action can be taken. This corrective action includes recalculation of qualified life and lowering temperatures when possible. It is much more preferable to know the condition of each safety related device and therefore have evidence of the conservatism in the qualified life.

In NUREG/CR-5762, infrared thermography was shown to be sensitive to age related degradation. As electrical equipment deteriorates,

overheating results from poor connections and less efficient heat transfer occurs.

The assumptions that form the basis of qualified life that involve material functions and material interactions can be addressed with a few refinements of existing practice. First, existing operation, maintenance and surveillance practices provide information on equipment operational state. Anytime safety related equipment fails to operate properly, a component root cause failure analysis (CRCFA) should be performed. CRCFA's should be scrutinized to see if the root cause finds evidence of material function capabilities and/or material interaction or otherwise indicates a mechanism which may not have been accounted for in the original qualification. This direct feedback to the EQ process based on the knowledge gained in CRCFA's is very important and necessary to assure that the state of the art in the original aging program was adequate.

Several examples exist where the CRCFA identified a flaw in the assumed conditions. NUREG/CP-0134 pages C5 to C-19 provide some examples. Additionally, a few recent failures of penetrations showed that the environment was more humid than originally assumed.

Staff Assessment:

Based on the information that has been reviewed under EQ-TAP Action Item 3, the term "qualified life" appears to be a misnomer. There are simply too many unknowns and uncertainties related to the qualification methodology (e.g., formulation of compounds; assembly, installation, operation and upkeep of equipment) to be able to make a specific determination of qualified life with any degree of accuracy. While it is not possible to establish a specific qualified life, the initial qualification testing methodology (i.e., DOR Guidelines, NUREG-0588, Cat. I, and NUREG-0588 Cat. II) does establish equipment qualification for some prolonged, but indeterminate, period of time.

In order to address concerns such as this one, the NRC staff should assure that full advantage is taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, so that EQ deficiencies can be identified and resolved on an ongoing basis. Implementation of the maintenance rule will help to resolve this issue for active components, and the staff should initiate action to include electrical equipment within the scope of the maintenance rule to fully address this concern.

The staff's assessment does not mean that equipment is no longer qualified; it simply recognizes some limitations that exist in the state of EQ technology that need to be addressed in a more focused fashion. Until such time that specific equipment qualification deficiencies are identified by enhanced monitoring methods, existing qualification is assured by the initial EQ testing that was performed, twenty-five years of research, and equipment performance and operating experience.

Finally, given the advances that have been made in our understanding of
on over the past 25 years, and based on the TMI-2 experience, PRA
sights, and operating plant experience, some adjustments in the
requirements may be possible and beneficial to the industry. The staff
h[illegible] receptive to proposed changes in the EQ methodology that are:
veloped as an industry initiative, and (b) demonstrated to be
hnically justified.

A correlation has not been established between artificial and natural aging.

Peer Review Comments:

a. True. In some instances, natural aging can be more severe than artificial. This has been demonstrated for cables.

b. A correlation may never be established for all components and materials.

c. This is a valid issue.

d. Several attempts have been made and are in progress towards correlating artificial aging with accelerated aging. UL and reliability testing have established that the same failure mechanisms were developed in artificial and accelerated tests. The EPRI/University of Connecticut project on cables and other materials is a long term attempt at answering this question. The use of Component Root Cause Failure Analyses of actual plant component failures provides direct feed back and an opportunity to correlate the artificial and natural aging.

e. Merits analytical resolution; correlation has been established between accelerated thermal and radiation aging and natural thermal and radiation aging under restricted conditions and for selected materials. However, it is true that the correlation between accelerated and natural aging of equipment assemblies is modest at best. This concern is one of the factors to be taken into account in a re-evaluation of the qualified life requirement. The following additional views were also expressed in response to other related issues and problem statements:

- The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of the art capabilities].

- More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements to resolve the problem of demonstrating a meaningful qualified life [re: age conditioning].

f. The idea behind artificial aging is to put equipment in an end of life condition before accident testing. Both the NRC and Industry have agreed that artificial aging is the best way to accomplish this. If there is a better way of accomplishing this goal, we would all like to here it.

Staff Assessment:

This is one of the uncertainties inherent in the EQ methodology that was referred to in the staff's assessment of the previous problem statement. To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance.

Some significant aging mechanisms cannot be accelerated. Some aging mechanisms required to be simulated may not be significant for all samples.

Peer Review Comments:

a. Probably true.

b. This is a valid issue.

c. Some aging mechanisms may not be adequately simulated because 1) the environment was not adequately identified and 2) daughter standards have attempted to define the aging simulation. This is an issue in two areas. First, failures within the last 6 years have identified higher than anticipated humidity conditions at several plants. Assumed low humidity requirements would allow dry heat aging. Also, IEEE-317 for penetrations, specifies dry heat aging. Given recent experience that humidity is higher than assumed, this standard should probably be modified and the state of the art in aging under higher humidity conditions may need to be improved. Other industries, for instance Navy and other military, do have standard humidity, salt spray, fungus, etc., test methods which could be employed.

d. Industry responsibility; best resolved by the industry. The first sentence identifies a valid concern; the fact that some significant aging mechanisms cannot be accelerated is one of the factors to be considered in re-evaluating the qualified life requirement. The second sentence appears to be inconsistent, because there is no requirement to simulate aging mechanisms that are not significant. The following additional views were also expressed in response to other related issues and problem statements:

- The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA

testing and enhanced condition monitoring in service [re: state of the art capabilities].

- More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements to resolve the problem of demonstrating a meaningful qualified life [re: age conditioning].

e. If something cannot be done, it cannot be done. If one aspect of a policy cannot be accomplished, that is not necessarily a reason to scrap the policy. In cases such as this, examples should be provided. Anyone can make negative statements about something that they disagree with.

Staff Assessment:

See the staff assessment of the previous problem statement.

Excessive reliance is placed on analytical aging calculations that may not be as reliable as testing, especially in older plants.

Peer Review Comments:

a. Could be true, but the significance may be small.

b. Maybe. Cost is a factor.

c. Industry responsibility; more NRC oversight may be needed. Neither accelerated aging nor aging analyses are very reliable as methods of estimating qualified life. In the case of laboratory aging, the problems include the uncertainties introduced by extensive extrapolation of experimental data in the application of the Arrhenius method to thermal aging, uncertainties introduced by extensive contraction of the life simulated to the laboratory aging time, and the fact that it is not practical to simulate some significant aging mechanisms. In the case of aging analyses, it is difficult to establish a mathematical model of the equipment. Basically, it is not feasible to account for aging in a technically rigorous way; regulatory oversight can at best rule out any excesses in the aging component of qualification, taking into account the limitations of the process. The following additional views were also expressed in response to other related issues and problem statements:

  - The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of the art capabilities].

  - More effort should be directed toward applying the lessons learned during the last two decades to modify qualification

requirements to resolve the problem of demonstrating a meaningful qualified life [re: age conditioning].

- The fact that some significant aging mechanisms cannot be accelerated is one of the factors to be considered in re-evaluating the qualified life requirement [re: acceleration of aging mechanisms].

- It is true that the correlation between accelerated and natural aging of equipment assemblies is modest at best. This concern is one of the factors to be taken into account in a re-evaluation of the qualified life requirement [re: correlation between natural and artificial aging].

d. The intent of this statement is not clear. Analytical aging calculations are (or should always be) based on testing. The problem in older plants is that there were neither artificial aging nor testing. Note that in this context, artificial aging and testing is synonymous. In addition, if this statement is suggesting that equipment in older plants should be tested to determine its capability after having been in service for some period of time, than I say that a test such as that is fine for getting some appreciation for past performance. However, such a test does not, and cannot, give any information about future performance of the equipment in question. On the other hand, if equipment in older plants is artificially age to some end of life condition and then tested, then some useful information may be obtained.

Staff Assessment:

See the staff assessment of the three previous problem statements.

Equipment "aging" has typically not been performed in the same functional state as it is used in the plant (i.e., energized or de-energized).

Peer Review Comments:

a. If true, the significance may be small.

b. May be true in some cases.

c. Typically?

d. Non-issue; addressed by IEEE standard.

e. In most cases in the plant, safety related equipment is not continuously energized and thus aging simulations utilizing unenergized specimens is appropriate. However when devices are energized, such as solenoid valves and motors, the aging in many cases did utilize energized devices.

f. Industry responsibility; best resolved by the industry. When it is feasible to energize equipment during accelerated aging, doing so may contribute to the simulation of some significant aging effects better than would be the case without energizing. However, it is not always feasible to energize the equipment, e.g., energizing at elevated temperature may introduce aging mechanisms that do not exist in real service. In such cases, an effort to account for the effects of energization can be made by treating the temperature rise at part of the service conditions, i.e., by calculating the operating temperature of a component by adding the temperature rise due to energizing to the environmental temperature. Research on this topic is not likely to be productive. The concern emphasizes the point made in earlier paragraphs that an effort is needed to replace qualified life as a major element of EQ.

g. It should have been.

Staff Assessment:

See the staff assessment of the four previous problem statements.

In lieu of attempting to define a "qualified life," it may be more appropriate to develop methods for addressing and/or monitoring in-service degradation.

Peer Review Comments:

a. I disagree. Qualified life means the time that a component can function in its installed environment and still be expected to withstand the effects of a DBE. Without understanding the failure modes induced in the test specimen by the DBE environment, how can periodic degradation monitoring accurately reflect how the component would react in the harsher environment created by the DBE? For that matter, how would we know that the component would function in a DBE on the first day it was installed?

b. Both are probably needed.

c. This is a valid issue.

d. Qualified life as currently used is normally interpreted as time. It is more appropriate to consider qualified life as a condition. As long as the condition of the equipment has not degraded to a condition impacting its performance during a DBA, it should still be considered within its qualified life. The current concept of a qualified life time does establish good controls on maintenance and replacement, but it is possible that an equipment's condition could deteriorate prior to the attainment of its qualified life. When this is the case, only the concept of condition monitoring would allow the identification of this degradation.

e. Good point; merits analytical resolution. The following

additional views were also expressed in response to other related issues and problem statements:

- The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of the art capabilities].

- More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements to resolve the problem of demonstrating a meaningful qualified life [re: age conditioning].

- IEEE has initiated an effort to consider preparation of a standard that will address the use of operating experience in qualification [re: use of test data].

f. It may very well be; this suggestion has been made previously but no one seemed to want to, or was willing to, develop an acceptable way of monitoring in-service degradation.

Staff Assessment:

See the staff assessment of the fourth problem statement (above).

- Margin requirements for demonstrating EQ (e.g., one hour minimum operating time, thermal aging, etc.) may be too severe and without sufficient justification; overall margin requirements need to be better defined with supporting technical justification.

Peer Review Comments:

a. I cannot respond without knowing the basis for the term "too severe."

b. This was done for conservatism.

c. Be careful -- margin can cover a lot of sins. Specifically, margin can address unknown and unquantified concerns.

d. This is a valid issue.

e. I haven't experienced the situation where the margins have been too severe and thus jeopardized the safety related equipment's performance. The use of margins does simplify the concerns about test equipment accuracy and seems appropriate considering the uncertainties in predicting DBA environments.

f. Industry responsibility; I am not aware of any specific, required values of margin. There are only "suggested values." Therefore, EQ requirements do permit the adjustment of margins to avoid any

values that are too severe or that cannot be justified. The problem is that it has become common practice to adopt the "suggested values" and anyone who chooses otherwise faces the burden of justifying the margins chosen. Incidentally, NUREG-0588 states that margin does not apply to the aging component of EQ. The following additional view was also expressed in response to another related issue or problem statement:

> The correlation between margin and its contribution to safety assurance is not likely to be established quantitatively with any reasonable amount of research; and it will therefore remain largely a matter of engineering judgment [re: margins in general].

9. The technical justification is the lack of preciseness in the accident scenarios, testing techniques, the number of specimens tested, and variations in manufacturing techniques. What is the justification for not having margin? If a good technical justification can be presented for not having the current margin requirements, perhaps margin requirements can be changed. But just to state that they are too severe without further elaboration is not justification.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustment in the requirements may be possible and beneficial to the industry. Also, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, some relaxation of the more rigorous requirements may be warranted. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

The need and/or ability to establish post-accident qualification beyond a two to four week period is questionable.

Peer Review Comments:

a. "I don't understand the issue."

b. Beyond EQ scope.

c. This is not clear; merits analytical resolution. I interpret this statement to mean that operability does not need to be demonstrated for periods exceeding two to four weeks, i.e., instead of periods of 100 days to a year. (I assume it does not mean that the LOCA test need not be longer than two to four weeks.) If the question is based on PRA studies that show LOCAs can be controlled with very little equipment operating after a few days, the NRC should document its position. As to the "ability"

to establish post-accident qualification for periods exceeding two to four weeks, the ability exists; but the cost increases with the duration of the period. The following additional views were also expressed in response to other related issues and problem statements:

- There is a need to evaluate the use of PRAs to justify short LOCA tests [re: test duration].
- It will be useful for the NRC to establish its position on the applicability of PRAs to equipment qualification [re: PRA implications].

d. A significant number of plants, and all of the most recently licensed plants, have establish post-accident qualification for 100 days. Some plants claim to have established post-accident qualification for one year (Seabrook, for example, established a post-accident qualification time of one year). One year is not a NRC staff requirement; in fact, it is not even a staff suggestion. TMI is an example where post-accident qualification and monitoring provided information far beyond the 100 days that the NRC staff requires. What support is there for the supposition that two to four weeks is sufficient?

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustment to the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in the methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- Time and dose rate testing requirements suggest that equipment qualification extends beyond the DBA and into severe accident space, which may not be entirely appropriate.

Peer Review Comments:

a. Equipment needed to mitigate an accident, such as a LOCA, must be demonstrated to be capable of performing its function. In some cases, this function occurs after the initiating event. This equipment has to withstand the environment created by the LOCA until called upon to perform. Examples could be a valve needed to align RHR to the containment sump or RG 1.97 indication needed to assist operators in assuring the plant is/remains stable.

b. Done for conservatism.

c. I don't understand "Time and dose rate requirements suggest that...." Documents like NUREG-0588 address only DBAs and the required post-accident service, and component qualification test reports are very specific about test conditions. What's the

problem? If severe accidents must be addressed, I think there's no doubt that much presently qualified equipment cannot be qualified for much service.

d. I agree. It is true that the doses used in EQ thus far may be very conservative, but I am convinced that this area does not merit additional research work because:

- The current accumulated dose, dose rate and time are based on releases calculated using TID 13444. Through the severe accident studies, it has been shown that this model may be too conservative and result in higher overall dose estimates for EQ purposes.

- But, given that the qualification effort is mostly complete and it has been shown that the materials used can withstand these levels, what is the issue here?

- Is it that by recognizing the levels of conservatism, we can relax the requirements? If so, it should be taken up under the systematic regulatory requirements review program.

- Also, this issue does not merit any additional research effort under the EQ TAP because plants operating today are not likely to derive significant benefits from such relaxation. The cost of cleaning up the paperwork to use the new reduced dose will be more than any potential benefit.

The ongoing literature review [being conducted under contract for the NRC] should provide confirmation that the materials used in qualified equipment do indeed have more than sufficient capability to withstand the doses currently used, and that the life limits are governed by thermal degradation.

e. Most equipment is qualified for some period of time after a DBA. This varies depending on the operational function of the safety related equipment and typically varies from 1 hour post DBA to 2 years post DBA.

f. The issue is not clear; what time is intended? I am not aware of any DBA qualification requirements that goes beyond the definition of LOCAs, MSLBs, and other HELBs.

g. All requirements within the scope of 10 CFR 50.49, including time and dose rate testing, are limited to design basis accidents.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some relaxation in time and dose rate requirements may be possible. The staff should be receptive to proposed changes in the methodology that

are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- The "double peak" requirement (i.e., exposure to two cycles of maximum temperature and pressure) is not representative of design basis conditions and may be too severe.

Peer Review Comments:

a. This was done for conservatism.

b. Are we planning to develop new equipment (and manufacturers) that will benefit from a single peak requirement?

c. Valid, but the NRC has adopted a conservative opinion.

d. I have not experienced that double peak testing during DBA simulations was too severe on equipment. It was changed to one peak testing because no credit was given for the assumed margin that it was supposed to represent.

e. Merits analytical resolution (i.e., analyze existing information to reach resolution). Introduction of the "double peak" in LOCA testing was based on engineering judgment, with the objective of achieving reasonable assurance of equipment operability by the EQ process. For example, it introduces conservatism that helps counter the concern that only one specimen is tested to establish qualification. While it may not be representative of design conditions, no such claim was intended. The question of whether it is too severe, and whether alternative LOCA testing profiles are adequately conservative, may merit more engineering judgment based on the extensive accumulated data base of LOCA testing (in the USA and in other countries); however, experimental research is not a priority.

f. The bounding qualification profiles in Appendix C (NUREG-0588) were generated based on a wide spectrum of postulated accidents. In some cases, these profiles can be considered to be overly conservative; however, in the absence of an approved plant-specific profile, this profile may be used and is considered the minimum bounding profile. In general, this profile may represent 6 hours of superheat conditions followed by 18 hours of saturated conditions. The actual degree of superheat is left as an open parameter for, as a minimum, the test temperature is to be 340°F for the time specified and the test pressure is to be equal to or greater than the containment design pressure. Obviously, the higher the pressure the less superheat that will exist for a fixed temperature. See NUREG-0588 Rev. 1, Part II, comment and resolution no. 97 for additional discussion on this issue. One should recognize that the curve in Figure C-1 of NUREG-0588 is provided for those BWR and PWR ice condenser facilities which do not have plant-specific accident profiles available for use in their equipment-qualification program. I must be clear here, the

"double peak" is not an absolute requirement, but rather, it is to be used in lieu of using a plant-specific containment temperature and pressure design profile (see NUREG-0588 Rev. 1, Sections 1.1(3) and 1.2(2).

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. Also, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, some relaxation of the more rigorous requirements may be warranted. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

The generic temperature profile that was allowed by the DOR Guidelines and NUREG-0588 for equipment qualification (i.e., T_{SAT} for PWRs and T_{SAT} + 20°F for BWRs) was not fully justified.

Peer Review Comments:

a. It was my understanding that the T_{sat} information was used as a tool for screening when judging individual plant DBA analyses. Each plant was required to have specific pipe break analyses of all potential line breaks and these were used in the qualification process.

b. Merits analytical resolution (i.e., analyze existing information to reach resolution). It would be helpful if the NRC documented its rationale.

c. You are stating that the DOR Guidelines and NUREG-0588 allows a generic temperature profile; the key word here is "allowed." These documents also allow a plant specific analysis. In this case, a plant specific analysis means a plant specific profile. For additional discussion on this issue see NUREG-0588 Rev. 1, Part II, comments and resolutions nos. 87 and 97.

Staff Assessment:

To the extent that the generic criteria are reasonably representative of the postulated accident environment, this simply becomes part of the uncertainty that is discussed in the staff's assessment of the fourth problem statement (above). However, in order to properly judge the significance of this issue, further action is warranted by the NRC staff to determine why the generic profiles could not be justified and how this relates to the plants where the generic profiles were used.

- Licensees typically do not evaluate the ambient temperatures around EQ equipment, basing equipment qualification on average bulk temperatures instead of local ambient temperatures.

Peer Review Comments:

a. Probably true, but in most cases this should be acceptable and normal plant monitoring should identify instances where significant discrepancies exist.

b. EPRI held a workshop on "Monitoring Equipment Environments During Nuclear Plant Operation" in April 10, 11, 1990. Many plants discussed their monitoring methods and many plants continue to add monitoring.

c. Industry responsibility; more NRC oversight may be needed. It is the industry's responsibility to account for significant deviations from bulk temperatures where equipment is installed, and more NRC oversight might help assure that this is done.

d. This is generally true, especially for equipment inside containment; although licensees should (and do) take into consideration local hot spots. In addition, most EQ programs separate the plants into EQ zones, and qualification is often based on the bulk temperature in each zone. Zone temperature data is used in aging calculations to determine the calculated life of equipment.

Staff Assessment:

The concern is two fold: (a) the amount of thermal preconditioning prior to EQ testing may not have been sufficient given the local ambient temperature, and likewise, (b) the peak accident temperature that the equipment was qualified for may not be sufficient. To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, the aspect of this concern that deals with the adequacy of thermal aging becomes one of minor importance. However, the aspect of this concern that questions the adequacy of the assumed peak accident temperature (as compared to the local ambient temperature) should be addressed by the NRC staff.

The regulations do not state the acceptance criteria for qualifying equipment based on operating experience.

Peer Review Comments:

a. Probably true, although it is difficult to demonstrate qualification of components that will see a harsh environment using operating experience since that experience will not duplicate a LOCA or HELB.

b. This is a valid point.

c. To my knowledge, the use of operating experience to qualify equipment has not been practiced and is frowned upon. Thus, it is

probably unnecessary to try to establish acceptance criteria for its use as an EQ method.

d. Merits analytical resolution; existing standards and RGs permit the use of operating experience essentially as a way of establishing qualified life. However, the restrictions are such that it is rarely a practical approach. The ultimate acceptance criterion is the provision of reasonable assurance that the specified safety function can be performed under applicable service conditions, including accidents. The following additional views were also expressed in response to other related issues and problem statements:

- IEEE has initiated an effort to consider preparation of a standard that will address the use of operating experience in qualification [re: use of test data vs. other methods].

- More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements [re: age conditioning].

- The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of the art capabilities].

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

Given more realistic assumptions for the release fractions, the timing of the release, the chemical form of the release, and accident mitigation effects resulting from equipment response, an immediate and large source term (TID) may be overly conservative and inappropriate.

Peer Review Comments:

a. Could be true.

b. True.

c. This is a valid issue.

d. The large radiation dose used in EQ programs in the US does seem to be overly conservative.

Modern sophisticated electronics are more susceptible to lower

radiation doses and thus the use of this equipment is jeopardized by having overly conservative radiation requirements. The alternative to new equipment is reliance on old, less efficient and less reliable technology.

e. Another source term (Draft NUREG 1465 source term) has now been approve by the NRC staff for use in the CE-System 80+ plant design. There is no requirement to switch to the new approved source term; however, those plants interested in switching should contact the NRC staff and for further discussions. In addition, the staff is also in the process of reviewing an additional source term for the AP-600 design. Consequently, there are currently two staff approved source terms available (TID 14844 and Draft NUREG-1465 source terms) for use in EQ; and upon completion of the NRC staff review of the source term proposed by the AP-600 design, there could be a third .

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in this regard that are (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- A general exemption for radiation qualification testing of equipment exposed to low-level radiation may be well suited for EQ purposes under certain defined circumstances.

Peer Review Comments:

a. Could be true.

b. I thought that we had a general exemption at 10^4 (or 10^5) Rads except for solid state electronics. If not, I agree there should be one.

c. This is not valid. We still do not understand long-term, low-dose effects.

d. Merits analytical resolution (i.e., analyze existing information to reach resolution). This point has been discussed at length by the EQ community; and relevant information exists in the literature. It should be feasible using existing information for the NRC to document its position.

e. The NRC staff position on this issue is that electronic equipment within the scope of the EQ rule that will be exposed to total integrated doses of radiation less than 10^3 rads (10^4 for other equipment) is considered to be in a mild environment. Therefore, environmental qualification in accordance with 10 CFR 50.49 is not required. This position is based on literature searches, comments

from industry, and NRC experience. If new or additional data is available to support a position different from this, that data should be presented to the NRC for review.

Staff Assessment:

See the staff assessment of the previous problem statement.

In areas designated as radiation-harsh only environments or high energy line break (HELB) areas, the conservative assumptions used in calculating radiation levels make it difficult (if not impossible) to upgrade to the more modern and efficient digital equipment.

Peer Review Comments:

a. Digital equipment (and analog) can be adversely affected by radiation so the focus of the issue should remain on ensuring safe operation of such equipment. If licensees can justify a lower level of radiation exposure than originally determined, this new value should be allowed.

b. If this comment is directed at the methods used to calculate the potential radiation environment, it should be discussed with the Radiation Protection Branch. Nevertheless, it is known and widely accepted in industry, that electronic equipment (which includes a significant amount of the more modern and efficient digital equipment) is more susceptible to radiation damage at lower thresholds than other equipment. If the current methods of calculating the amount of radiation in a given environment is inaccurate or incorrect, then perhaps a fresh look at this situation is warranted. However, evidence to support a new investigation should be presented to the Radiation Protection Branch.

Staff Assessment:

See the staff assessments of the two previous problem statements.

It may not be appropriate for the NRC to require licensees to either implement the new source term "across-the-board" or not at all, instead of allowing licensees to use the new source term initially for discrete applications (such as in EQ radiation-harsh environments). Allowing some flexibility in applying the new source term would allow licensees to recalculate the exposure levels of some EQ components without expending significant resources to update all of the post-accident procedures and calculations relative to EQ. Flexible use of the new source term could help to eliminate some components from the costly requirements of 10 CFR 50.49.

Peer Review Comments:

a. The focus of the issue should remain on ensuring safe operation of equipment. If licensees can justify a lower level of radiation

exposure than originally determined, this new value should be allowed.

b. This is not valid. You can not have it both ways; you either use the new source term or you do not.

c. The intent of this comment is not clear. It seem as if it is being suggested that the NRC should permit partial use of the old and partial use of the new source terms for EQ. If this is the case, then we would be creating a third source term. If someone is proposing a new source term for EQ only, this proposal should be presented to the NRC for review and comment. Otherwise this comment seems technically disoriented.

Staff Assessment:

See the staff assessments of the three previous problem statements.

The cost of qualification testing is a barrier to the introduction or adaptation of new products into the nuclear industry.

Peer Review Comments:

a. TMI demonstrated the need for EQ. While cost is a factor, safety must be maintained.

b. No doubt about it.

c. The current NRC research program may result in reduction of some requirements.

d. I do not agree. Cost per se should not be a basis for modifying EQ requirements; reducing the cost can be justified only by changes that do not compromise reasonable assurance of safety. While the statement is a reasonable observation, it does not by itself suggest a course of action.

e. Qualification testing is necessary because it provides information about equipment that is unattainable in any other manner. It insures quality, provides confidence, traceability, and most of all it provides and demonstrates safety.

Staff Assessment:

Given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience, PRA insights, plant operating experience, some adjustments in the requirements may be possible and beneficial to the industry. The staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

2. Additional technical issues and other considerations that were identified as "potential issues" related to the EQ methodology include:

General Peer Review Comments:

a. The following "technical issues" highlight the need for the margin that has been built into the process.

b. While several of these issues (e.g., the effects of hot, humid conditions; the effects of steam leaks and inadvertent spray actuation during normal operation; deformation of cable jacket and insulation at high stress points; and others), must be considered during EQ testing, they are not issues that can be (or should be) resolve within the context of the requirements of the EQ rule. Rather, these are normal operating conditions that need attention and should be addressed by maintenance programs. These conditions existed before there were EQ requirements and they would still exist even if there were no EQ requirements. When they are resolved for normal operating conditions, they will no longer be a concern for EQ.

c. The following additional technical issues should be added to the list:

- Fire retardant insulation and jacket materials contain halogen compounds that are released during irradiation and thermal exposure. Halogens, in particular chlorine, trapped between the jacket and insulation, can enhance the degradation of the insulation. Aging cables without a jacket can provide a nonconservative estimate of insulation life.

- It has been established that low dose rate has a greater impact on degradation than high dose rate. A dose rate value should be established that will provide a conservative estimate of degradation. This value would then be used to irradiate materials to simulate field service aging.

- For the majority of instrumentation cables, the leakage currents have not been measured during a DBA. Leakage currents should be determined for the whole cable system including splices, penetrations and end connections.

Staff Assessment:

To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, the cable degradation concerns are of minor importance. With regard to the third concern pertaining to leakage currents, action is required by the NRC staff to better understand and resolve this issue.

- qualification/certification of testing laboratories:

Peer Review Comments:

a. This was a big issue around the 1983 time frame at the EDO level. It fell through because it was impractical.

b. I disagree. As one of those involved in the long and arduous effort on this topic during the early 1980s, it is still fresh in my memory, and every one involved agreed that this is not desirable. If it was considered then to be unfeasible economically, and undesirable technically, what has changed now to warrant its reconsideration? Do we really want to be lulled into a false sense of security provided by this "accreditation" process. Even its big proponent, IEEE, which published IEEE-650 has withdrawn the standard for lack of interest and acceptance by the labs and the industry.

c. This is a valid issue.

d. Qualification and certification of testing laboratories should be performed using common non-nuclear industry processes and imposing nuclear QA requirements.

e. I do not agree. Considerable effort was expended on this topic about ten years ago. It was concluded that, while there might be some benefits to certification, the level of EQ business was too small for test laboratories to absorb its costs. Since the level of EQ business is much smaller now than it was ten years ago, the prospect of implementing a certification program now appears to be negligible.

f. Examples should be cited when statements such as this are made.

Staff Assessment:

The staff agrees with the view (stated above) that qualification and certification of testing laboratories should be established using common non-nuclear industry processes and imposing nuclear QA requirements. While it is the responsibility of the industry to ensure that testing laboratories are adequately qualified to perform EQ testing, the NRC staff should assure that qualification testing is being properly and consistently performed through development and implementation of ongoing EQ audit and inspection activities.

- determination and resolution of worst-case electrical conditions;

Peer Review Comments:

a. I disagree. To the best of my knowledge, to the extent practical, such conditions have been included in the qualification programs. It is true there have been a few lapses. This is an education problem but not a problem of lack of, or clarity of requirements. EQ was a rapidly evolving technology when much of the work was done. Surveillance, maintenance and condition monitoring, if properly implemented, should take care of any past lapses. Training and education of engineers involved in specification of EQ requirements should minimize, if not prevent recurrence.

b. The statement is too non-specific.

c. The electrical extremes of most equipment is known and demonstrated during qualification programs.

d. Industry responsibility; merits analytical resolution. A valid concern since worst case conditions are sometimes overlooked in current EQ practice. However, this does not absolve the nuclear industry from identifying and resolving worst case conditions as part of its responsibility to operate plants safely. A tightening of EQ, surveillance, and maintenance requirements can help assure that adequate attention is given to worst case conditions.

Staff Assessment:

While the staff agrees with the view (stated above) that the licensees are responsible for identifying and resolving plant-specific conditions that were not properly accounted for during EQ testing, the NRC staff should: (a) assess the information gained over the past 25 years pertaining to EQ and worst-case conditions, and (b) assess past qualification practices, to determine if any specific concerns exist. The NRC staff should assure that plant-specific conditions are properly accounted for through development and implementation of ongoing EQ audit and inspection activities.

- resolution of radiation and temperature stratification effects and hydrogen burn scenarios;

Peer Review Comments:

a. I agree that such stratification effects may not have been addressed in the qualification establishment phase. Indeed, they could not have been because these are site and configuration specific problems that could not be addressed in any generically developed program such as EQ. Only review of operating and failure experience, and root cause analysis could address these effectively. I am familiar with some instances of such conditions having been identified and corrected through vigilance in maintenance and root cause analysis programs. Therefore, I must conclude that valid as this may be as an EQ issue, it merits research attention only to periodically review failures and root causes and notify licensees. This function is effectively being performed through the existing NRC generic communication program.

My recollection is that the EPRI test program performed during the mid-1980s, did show that hydrogen burn is not a significant concern for harsh environment qualified equipment.

b. This is a valid issue.

c. They probably do (at least hydrogen burn). How will you address hydrogen burns?

d. Hydrogen burn testing was done by EPRI in the 1980's to establish that the impact on otherwise harsh qualified equipment was insignificant.

e. Industry responsibility; merits analytical resolution. The industry can contribute to resolution of temperature and radiation stratification effects in part by monitoring environmental conditions in appropriate parts of the plants.

The NRC conducted an extensive investigation of hydrogen burn scenarios about a decade ago. It is not clear whether the concern is due to lack of knowledge of the NRC's resolution or disagreement with the resolution. If existing information on this topic is inadequate or not adequately promulgated, the NRC can take corrective action.

f. Hydrogen burn scenarios are outside the scope of the EQ rule. Temperature and radiation stratification that result from a design basis accident are within the scope of the EQ rule, and equipment within the scope of the rule should be qualified to withstand these conditions.

Staff Assessment:

The NRC staff should assess the information gained over the past 25 years pertaining to EQ, hydrogen burn, and stratification effects, and determine if a significant safety problem exists.

- resolution of MSLB vs. LOCA environmental conditions;

Peer Review Comments:

a. This is not an issue.

b. I don't appreciate the MSLB vs. LOCA consideration because EQ testing uses enveloping techniques to establish worst case requirements. When an item is required to be qualified to both MSLB and LOCA conditions, both profiles are enveloped by one test, which is inherently more severe than either one alone.

c. The issue is not clear.

Staff Assessment:

This concern was identified by the staff because MSLB conditions (which could be more severe than LOCA conditions) were not recognized during initial qualification efforts. Further, the subsequent practice of comparing the MSLB equipment surface temperature to the bulk LOCA temperature as a basis for MSLB qualification was questioned. Action by the NRC staff is necessary to determine, based on the additional information that has been obtained over the past 25 years and based on past qualification practices, whether this concern represents a significant safety problem, and whether additional measures are warranted.

- self-heating effects of cables;

Peer Review Comments:

a. I disagree. This has been addressed by assuming a cable operating temperature is at rated conditions or very close thereto. If anything, the industry practice is probably more conservative than it needs to be given the derating of cables in their applications.

b. This is a valid issue.

c. Self heating effects in cables has been typically considered. This normally would effect only power cables and cables are normally powered to worst case conditions during DBA testing.

d. I do not agree. Cable qualification practices do account for the self heating effect of cable energization; in fact, the industry claims that this was done too conservatively in some EQ programs.

Staff Assessment:

Based on the peer review comments (above), it appears that self-heating effects have been considered at least to some degree. Also, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance.

- difficulties in simulating accident conditions (e.g., containment spray, humidity, etc.);

Peer Review Comments:

a. This is not a valid issue.

b. Properly equipped commercial laboratories have no problem simulating accident conditions.

c. The issue is not clear.

Staff Assessment:

There may be some variations and uncertainties in the actual conditions that are established in the EQ test chamber, but these should be minimal if the chamber is properly instrumented. Recognizing that the postulated accident conditions were determined through analytical methods that also contained inherent uncertainties, the concern seems to be of little significance. However, development and implementation of an ongoing audit and inspection program for EQ testing laboratories will help to address this issue. Also, see the staff assessment regarding certification of EQ testing laboratories (above).

- the effects of hot, humid conditions;

Peer Review Comments:

a. I agree, humidity cannot be accelerated. Heat in combination with humidity may apply to specific locations in some plants. Generic programs such as EQ cannot address this effectively. But properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective. Additional research cannot satisfactorily address this.

b. This is not a valid issue.

c. The long term exposure of materials to heat and humidity, if not identified as part of the assumed environment, will cause differences in performance. Some effort should be made to identify the environment properly and research simulation techniques. The military style simulations may need modification.

d. Merits analytical resolution (i.e., analyze existing information to reach resolution). This is a valid concern in accounting for aging degradation, because there is no practical method of accelerating humidity effects that can be correlated to a qualified life. However, there are humidity stress tests that can at least provide some indication of the endurance of equipment under humid conditions. Humidity stress testing has been incorporated into at least one standard, IEEE Std 650 for battery chargers and inverters.

Staff Assessment:

To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance. However, given the advances that have been made in our understanding of EQ over the past 25 years, and based on the TMI-2 experience and PRA insights, some adjustments in the requirements may be possible and beneficial to the industry. The NRC staff should be receptive to proposed changes in this regard that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- the effects of steam leaks and inadvertent spray actuations during normal operation;

Peer Review Comments:

a. I agree, this is a valid concern. But, it is one where only experience in the plant can guide the determination of areas of vulnerability. It may apply to specific locations in some plants. Generic programs such as EQ cannot address this effectively. But, properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective. Additional research cannot satisfactorily address this.

b. This is a valid issue; what about operating experience to address this?

c. Equipment qualified to harsh environments should not experience problems when exposed to steam leaks and inadvertent spray actuations. If they do, then the qualification is suspect until the issue is resolved.

d. Industry responsibility; merits analytical resolution. This is a valid concern. Where experience predicts that certain equipment in certain locations is expected to be subject to steam leaks and inadvertent spray actuations, the EQ program should incorporate testing (such as humidity stress tests) to simulate these service conditions. Where such events were not anticipated in the EQ program, the existing program should be supplemented by additional testing or enhanced condition monitoring to assure that equipment is refurbished or replaced when it is no longer able to operate as required during a DBA.

Staff Assessment:

The staff agrees with the view (stated above) that properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective in addressing this problem. Therefore, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance.

- deformation of cable jacket and insulation at high stress points;

Peer Review Comments:

a. I disagree. I recall that some work was done by Sandia and TVA to answer this concern. That should be sufficient to address the concern generically. Still, this concern will remain because generic programs such as EQ cannot address this completely for all variations. But, properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective. Additional research cannot satisfactorily address this issue fully.

b. This is a valid concern; what about operating experience to address this issue?

c. Sandia did perform some tests of cables hung over sharp edges and concluded that cut through did not occur. Given standard cable pulling practices and cable routing practices, sharp edges is most likely a rare event and not considered a common mode failure.

d. Industry responsibility; best resolved by the industry.

Staff Assessment:

See the staff assessment re: the effects of steam leaks (above).

- dust effects;

Peer Review Comments:

a. I agree. Generic programs such as EQ cannot address this effectively. But properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective. Additional research cannot satisfactorily address this.

b. This is a valid issue; what about operating experience to address this issue?

c. Most harsh qualified items are qualified assuming exposure to sprays and steam, or otherwise are protected by seals and sealants, which have documented effectiveness in their own EQ tests. Thus, dust particles, which are assumed to be larger, would have little effect. Additionally, most LOCA simulation chambers would contain considerable contamination as sprays are recirculated, thus simulating dust and other contamination conditions.

d. Industry responsibility; best resolved by the industry.

Staff Assessment:

See the staff assessment re: the effects of steam leaks (above).

- long-term exposure to moisture;

Peer Review Comments:

a. This may be the most significant concern.

b. I agree. Generic programs such as EQ cannot address this effectively. But properly implemented surveillance, inspection, maintenance, and root cause analysis programs can be effective. Additional research cannot satisfactorily address this.

c. This is a valid issue; what about operating experience to address this concern?

d. Industry responsibility; merits analytical resolution. The following additional views were also expressed in response to other related issues and problem statements:

   - Where experience predicts that equipment in certain locations is expected to be subject to steam leaks and inadvertent spray actuations, the EQ program should incorporate testing (such as humidity stress tests) to simulate these service conditions. Where such events were not anticipated in the EQ program, the existing program

should be supplemented by additional testing or enhanced condition monitoring to assure that equipment is refurbished or replaced when it is no longer able to operate as required during a DBA [re: the effects of steam leaks].

Humidity represents a valid concern in accounting for aging degradation, because there is no practical method of accelerating humidity effects that can be correlated to a qualified life. However, there are humidity stress tests that can at least provide some indication of the endurance of equipment under humid conditions. Humidity stress testing has been incorporated into at least one standard: IEEE Std 650 for battery chargers and inverters [re: the effects of hot, humid conditions].

Staff Assessment:

Focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, will help to address this concern. However, NRC staff action is necessary to determine, based on the additional information that has been obtained over the past 25 years, whether long-term exposure to moisture represents a significant safety problem and whether additional measures are warranted.

- the impact of fire scenarios, protective features, and fire fighting activities, including (for example) smoke, fire-retardant coatings and fire barriers, fire suppression system actuation, and broken or leaking flammable gas lines;

Peer Review Comments:

a. I agree, this is probably a valid concern and may not have been fully addressed in existing qualifications. A study of the expected effects, the methods for factoring them in establishing aging parameters, and determination of the levels of margins that may exist in current aging programs is appropriate.

b. This is a valid issue; needs to be addressed.

c. Industry responsibility; merits analytical resolution.

Staff Assessment:

Action is required by the NRC staff to assess the impact of fire scenarios on EQ and to determine if this represents a significant safety problem and whether additional measures are required.

- the consequences of combustible gas and chlorine formation;

Peer Review Comments:

a. I disagree, this is plant design and physical facility

configuration control issue. It should not be treated as an EQ issue.

b. This is a valid concern; needs to be addressed.

Staff Assessment:

Action is required by the NRC staff to assess the consequences of combustible gas and chlorine formation and to determine if this represents a significant safety problem and whether additional measures are required.

- interface effects between components that are tested separately;

Peer Review Comments:

a. I agree; with some exceptions, the test programs completed thus far have addressed interfaces mostly separately. But, it should be noted that they have been addressed in the context of the overall qualification of the equipment item to assure that the safety functional capability of the equipment in harsh environments are not compromised. We may argue about the acceptability of some of the evaluation practices employed. Barring a detailed evaluation of the various configurations of interfaces, and determining an acceptable method for each configuration (of course, we may need tests to validate), it will be impractical to determine whether or not there is an EQ issue here that could potentially challenge what has been done to date. From my knowledge of what has been done in qualification, and the design installation, maintenance and testing aspects of several classes of equipment, my opinion is that such an effort may not be cost effective. Individual evaluations on a case basis, particularly based on failure experience review (which incidentally is the current NRC and industry practice) may be more effective.

b. This is a valid concern; needs to be addressed.

c. Interfaces of equipment are qualified along with the equipment. The test laboratories have to interface to the equipment inside chambers and thus this knowledge was passed along to the industry in EPRI NP-5000, "Handbook on Electrical Interface Sealing," 1988.

d. Industry responsibility; more NRC oversight may be needed.

Staff Assessment:

The staff agrees with the view (stated above) that licensees are responsible to ensure that equipment interfaces are adequately qualified. Focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, will help to address this concern. However, NRC staff action is necessary to

determine, based on the additional information that has been obtained over the past 25 years, whether specific equipment interface problems have been identified that should be addressed.

- EQ boundary restrictions (e.g., the compensatory actions that must be taken for a short-term breach of mild-to-harsh area EQ boundaries are excessive when compared with the probability of a LOCA/HELB event during a maintenance evolution):

Peer Review Comments:

a. I agree, this is a valid concern but it is not one that could be resolved by additional research. It should be addressed through plant configuration control programs.

b. This is a valid issue; needs to be addressed.

c. The issue is not clear.

d. Engineering judgement and common sense should resolve this issue.

Staff Assessment:

Licensees occasionally find it desirable to remove or disable EQ boundaries (e.g., flood walls, concrete plugs, etc.) in order to facilitate maintenance activities. However, removing the barrier may cause otherwise operable safety-related equipment to be exposed to harsh-environment conditions that this equipment has not been qualified for until the barrier is reestablished. This is a valid problem that is best addressed by industry, and the NRC staff should be receptive to proposed resolutions of this problem that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- scheduling constraints on performing periodic maintenance (i.e., EQ components are considered to be inoperable at the end of their qualified life, even though the method used to determine "qualified life" contains many assumptions and conservatisms);

Peer Review Comments:

a. I agree. This concern arises because of our treatment of qualified life as cast-in-concrete number, despite all of its uncertainties. This concern will be moot if we can agree that, given the nature of the uncertainties behind the qualified life estimates, it is prudent to treat it more as a yard stick than as an absolute do-or-die number. As an interim solution, the NRC might consider allowing the utilities to use the 25% grace period that is now allowed for Tech. Spec. surveillance, for EQ maintenance also. A justification can be developed for this.

b. This is a non-EQ issue.

c. Great care should be taken in considering the granting of

flexibility for end of life determinations. The reason assumptions and conservatisms are used is to deal with a complex process for determining end of life. These assumptions and conservatisms must be replaced with equally valid inputs before they are removed or altered.

d. Merits analytical resolution. Qualified life is at best an estimate of the period for which the required operability is reasonably assured. The uncertainties in qualified life determinations are not consistent with considering equipment inoperable at the end of qualified life. There is now a need to evaluate alternatives to the qualified life requirement. Operating experience and enhanced condition monitoring are among the alternatives that should be considered. The following additional views were also expressed in response to other related issues and problem statements:

- Neither accelerated aging nor aging analyses are very reliable as methods of estimating qualified life. Basically, it is not feasible to account for aging in a technically rigorous way. Regulatory oversight can at best rule out any excesses in the aging component of qualification, taking into account the limitations of the process [re: reliance on analytical aging calculations].

- The experience of the last two decades has demonstrated the difficulty of establishing qualified life without large uncertainty. One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of the art capabilities].

e. Industry responsibility; best resolved by the industry.

f. At the end of qualified life EQ components are/or should be capable of withstanding a design basis accident. Therefore, it may appear to be capable of providing additional service. If a plant wants to continue to use a component, additional testing is required to demonstrate that the "family of components" is capable of providing additional service in addition to being capable of withstanding a design basis accident. The method used to determine qualified life is not perfect; but until a better method is developed, it is the best available.

Staff Assessment:

The staff agrees with the view (stated above) that this problem is best addressed by industry, and the NRC staff should be receptive to a proposed resolution of this problem that is: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- the accuracy of test instrumentation;

Peer Review Comments:

a. This has been sufficiently dealt with through industry review and NRC audits. It is true that an occasional lapse here and there has been discovered, and will probably continue to be discovered in the future as well. We must recognize that in any human endeavor, it is impractical to eliminate such lapses, especially when it involves exacting attention to numerous details. The answer lies in our QA/QC systems, not additional research.

b. This is not an EQ issue; this is QA.

c. Industry responsibility; I am not aware of any deficiency in the requirements for test instrument accuracy and calibration. If there is any deficiency with compliance, it is primarily the industry's responsibility to correct the situation.

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], this does not appear to be a valid concern. Instrument accuracy was specifically reviewed by the staff during the on-site EQ inspections that were performed at each plant.

- documentation requirements; and

Peer Review Comments:

a. No further work should be required on this. The standards and NRC requirements are sufficiently clear. This is an education problem, not a research issue.

b. This is not an issue; established by IEEE Standards.

c. The concern is not clear; the specific documentation problem(s) should be identified.

d. Based on my experience in reviewing EQ documentation, I often wished for more relevant information.

e. Documentation is required by the Code of Federal Regulations (i.e., 10 CFR 50.49 (J)). One of the primary purposes for documentation is to insure quality and traceability of components. Changing the Code of Federal Regulations requires rule making. The NRC has no basis nor inclination to pursue such a change.

Staff Assessment:

A certain level of documentation must be maintained in order to be able to demonstrate that qualification does in fact exist. The staff's review under EQ-TAP Action Item 3.e [10] indicated that specific documentation requirements were imposed, but perhaps it could be argued that the requirements are too strict and unfounded. The staff should be

receptive to proposed changes in the requirements that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified.

- other considerations relative to EQ, such as mechanical and flow-induced vibration, seismic effects, dynamic effects, etc.

Peer Review Comments:

a. I disagree. These are not within the scope of environmental qualification. They should be addressed separately.

b. This is a valid issue.

c. The issue is not clear.

Staff Assessment:

The resolution of other issues that were handled separately from EQ but that could have a degrading influence on equipment qualification, such as the issues of mechanical and flow-induced vibration, seismic effects, dynamic effects, etc., should be reviewed to assure that EQ has not been compromised by the resolution of these other issues.

The following problem statements expand on certain aspects of this issue:

- Continuous submergence prior to harsh exposure has not been addressed.

Peer Review Comments:

a. I am not aware of any areas where EQ equipment is normally submerged.

b. Need it be addressed? If it's part of the normal environment, aging should address it. But does it really happen for electrical equipment?

c. This is a valid issue.

d. The NRC staff position on submergence is straight forward and clear. If an item is submerged during normal operation and/or during accident conditions, then that item should be tested for EQ purposes in the submerged condition. The staff has always stated that the test conditions should always, to the extent practicable, represent the installed conditions. To date, no one has presented an acceptable alternative to the NRC staff position on submergence.

Staff Assessment:

Focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, on an on-going basis will help

to address this concern. However, NRC staff action is necessary to determine to what extent this is a valid concern; especially for plants that came under the EQ criteria of the DOR Guidelines and NUREG-0588, Category II.

- The momentary electrical effects of the postulated initial peak temperature and radiation stresses have not been addressed.

Peer Review Comments:

a. Why not? Test specimens should have been energized at the time of the event's simulation so why is this an issue?

b. This is not a valid issue; this is checked during LOCA.

c. The issue is not clear.

d. This comment needs clarification.

Staff Assessment:

Based on the peer review comments, this does not appear to be a valid concern. However, the NRC staff should review the information that has been gained over the past 25 years relative to EQ and electrical phenomena that are likely to occur during event scenarios to determine whether further action is warranted to address this concern.

- Comparison of the calculated MSLB surface temperature to the LOCA bulk temperature may not assure that the equipment will survive the MSLB environment.

Peer Review Comments:

a. I am not aware of this issue.

b. Needs to be considered.

c. Industry responsibility; merits analytical resolution. Although it is the industry's responsibility to account for MSLB effects, additional guidance from the NRC would be helpful.

d. Equipment qualified in accordance with the requirements of 10 CFR 50.49 will withstand the worst-case design basis accident conditions. Often the worst-case conditions are a combination of LOCA and MSLB scenarios. A LOCA will likely produce the peak conditions and a MSLB will likely produce harsh conditions for a longer period of time. Consequently, plants often develop a composite profile for testing purposes that includes peak LOCA conditions with the duration of a MSLB. This approach assures equipment survival for both LOCA and MSLB environments.

Staff Assessment:

The concern is that the bulk LOCA temperature is an averaged value, and

temperatures near specific components may be more or less than the bulk value, depending on plant-specific conditions such as temperature stratification effects. So, the concern is two-fold: (a) qualification of equipment for LOCA conditions based strictly on the containment bulk LOCA temperature may not be sufficient, and (b) use of the bulk LOCA temperature as a basis for qualification of equipment for MSLB conditions may not be sufficient. Action by the NRC staff is necessary to determine, based on the additional information that has been obtained over the past 25 years and based on past qualification practices, whether the temperatures that were required for LOCA and MSLB qualification were appropriate and whether additional measures are warranted.

- Environmental conditions for accidents other than for LOCA (such as for MSLB) were not defined for at least 65 power reactors. The staff failed to recognize this factor in its resolution of Task Action Plan Item A-21.

Peer Review Comments:

a. In the early '80s, NRR formed an EQ Branch to resolve issues such as this one. The Containment Systems Branch provided input of containment temperature profiles of both MSLB and LOCA to the EQ Branch. The issue should have been resolved more than ten years ago by the EQ Branch, but the resolution may not have been recognized and/or characterized properly by RES.

b. I am not aware of this issue.

c. Based on a value/impact assessment, the NRC staff concluded that Task Action Plan Item A-21 has a low priority ranking. However the accident analyses for plants do consider a MSLB accident, and licensees develop pressure and temperature profiles based on those considerations. EQ test profiles are subsequently developed from those accident analyses.

Staff Assessment:

See the staff assessment for the previous problem statement.

- The staff's "final position" regarding the velocity profile in containment during blowdown was pending completion of Task A-21. However, the staff's resolution of Task A-21 was incomplete (see the previous problem statement) and this issue may need to be revisited.

Peer Review Comments:

a. A "final position" on this issue is not apparent, but there is no need for such a generic resolution . The velocity profile is only needed in very few cases (such as AP600), where plant-specific detailed analysis should be performed.

b. I am not aware of this issue.

Staff Assessment:

The concern is two-fold: (a) resolution of the "velocity profile" aspect of TAP A-21 may not be appropriate if the velocity profile is dependent on the resolution of MSLB vs. LOCA conditions (see the previous problem statement), and (b) the "velocity profile" represents a dynamic effect that may not have been adequately addressed in terms of EQ (see the last bullet under B.2, above). Action is required by the NRC staff to address this concern.

For plants qualified under the DOR Guidelines and up to the mid-1970s, vendor specifications for EQ equipment contained few performance requirements describing the acceptable performance of cable systems under harsh conditions.

Peer Review Comments:

a. Is there a problem? Separating the shortcomings of the DOR approach, each cable qualification test demonstrated that cable's ability or inability to function in the originating plant's harsh environment.

b. Given the change rate of equipment/cables, many of the old components may not be in the plant. The first step would be to perform an inventory of the materials in the plant.

c. Industry responsibility; more NRC oversight may be needed. It is the industry's responsibility to verify that the qualification documentation provides reasonable assurance that cable safety functions can be performed as required. If the original qualification is found to be deficient, additional testing or other approaches to assuring operability may be necessary. More oversight by the NRC may be necessary to verify that cable qualification programs are adequate in this regard.

d. This may be true, however in accordance with 10 CFR 50.49 (k) "Applicants for and holders of operating license are not required to requalify electric equipment important to safety in accordance with the provisions of this section if the Commission has previously required qualification of the equipment in accordance with "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in operating Reactors," November 1979 (DOR Guidelines), or NUREG-0588 (For Comment version), "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." However, replacement equipment must be qualified in accordance with the requirements of 10 CFR 50.49.

Staff Assessment:

The performance requirements of equipment are determined by the results of accident analyses, not vendor specifications. However, vendor specifications (to the degree that they exist) can provide additional

assurance that installed equipment are suited for their specific applications. Therefore, the staff agrees with the view (stated above) that it is the licensee's responsibility to ensure that the qualification documentation provides reasonable assurance that equipment safety functions will be performed given plant-specific considerations.

- The Seismic Qualification Utility Group guidelines do not recognize the performance requirements of equipment during a design basis event (DBE), only the damage to equipment that results from a DBE. More specific seismic qualification requirements may be needed.

Peer Review Comments:

a. I disagree. In the area of relay performance (contact chatter/bounce), SQUG does consider equipment performance during the event.

b. Merits analytical resolution. This issue merits study because of the lack of consensus concerning the applicability of earthquake damage data to seismic qualification. Lack of damage during an earthquake does not, per se, assure operability during an earthquake. Therefore, it seems that earthquake data needs to be supplemented with analysis and some testing (less than a complete seismic test) to provide an adequate technical basis for seismic qualification. The conclusions of such a study should not be inconsistent with what are acceptable procedures for seismic qualification of large equipment where testing is not feasible.

c. Seismic qualification is not within the scope of the EQ rule.

Staff Assessment:

See the staff assessment of the last bullet under B.2, above.

- The limiting undervoltage and underfrequency conditions (i.e., postulated electrical conditions for seismic as compared to other hostile environmental conditions) may not have been assumed for establishing qualification, especially for plants subject to the DOR Guidelines.

Peer Review Comments:

a. I am not aware of this issue.

b. Seismic is not included in 10 CFR 50.49 and was not addressed in the [NRC staff's] operating reactor EQ inspections.

c. This statement is not exactly clear. If the limiting undervoltage and underfrequency conditions result from a seismic event, then qualification for these conditions should be covered under the seismic qualification criteria (i.e., Section 3.10 of the standard review plan). The DOR Guidelines does not cover seismic qualification.

Staff Assessment:

See the staff assessment of the last bullet under B.2, above.

Summary

Based on the staff's review of EQ methodology issues, the following recommendations were made:

a. In order to account for the numerous uncertainties that exist relative to equipment qualification, to provide assurance of continued qualification over time, and to identify any EQ deficiencies that may exist, the NRC staff should assure that licensees take full advantage of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information on an ongoing basis. To facilitate this effort, the staff should also initiate action to include electrical equipment within the scope of the maintenance rule.

b. 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. For example, this data base should be used as an initial step in addressing the specific EQ issues listed in f, g, h, and i (below).

c. Any further EQ research by the NRC staff should only be performed if: (a) it is based on a well defined need for specific information, (b) there is a good likelihood that the desired information will be obtained, and (c) the cost of the proposed research activity is justified in terms of the expected benefits to public health and safety.

d. Certification of EQ testing laboratories in accordance with generally accepted non-nuclear practices along with nuclear QA standards is needed to assure that EQ testing is properly and consistently performed. Also, the NRC staff should periodically monitor the performance of EQ testing laboratories through development and implementation of EQ audit and inspection activities.

e. The NRC staff should assure that plant-specific conditions are properly accounted for by licensee EQ programs through development and implementation of ongoing EQ audit and inspection activities and through issuance of generic communications when appropriate.

f. The use of "excess margin" to justify short-duration LOCA tests that were allowed for the DOR Guidelines plants should be reviewed to assure that a significant safety problem does not exist.

g. Further review is needed to determine why the generic temperature

profiles for PWRs and BWRs were not fully justified and how this relates to those situations where the generic temperature profiles were used.

h. Further review is needed to assure that the "velocity profile" aspect of TAP A-21 was adequately addressed. First, the staff's resolution 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 second, the "velocity profile" represents a dynamic effect that may not have been addressed in term of EQ (see j. below).

i. Further review is needed to better understand and more fully address the following concerns relative to EQ:

- 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.

j. The resolution of other issues that were handled separately from EQ but that could have an effect on equipment qualification, such as the issues of mechanical and flow induced vibration, seismic effects, dynamic effects, etc., should be reviewed to assure that EQ has not been compromised by resolution of these other issues.

k. A large number of the concerns suggested that by using the additional information that has been obtained over the past 25 years effectively, and based on the TMI-2 experience and PRA insights, some adjustments in the EQ methodology may be possible and beneficial to the industry. This is especially true recognizing that more emphasis is needed on maintaining equipment qualification over time and some "trade-off" may be appropriate. The NRC staff should be receptive to proposed changes and improvements in the EQ methodology that are: (a) developed as an industry initiative, and (b) demonstrated to be technically justified. For example, the following elements of the qualification methodology were cited as potential candidates for improvement:

- use of analysis and operating experience versus test data;

- amount of preconditioning required and possible use of stress testing as an alternative to this requirement;
- test margin requirements;
- post-accident operating time requirements;
- mandrel bend test requirements;
- treatment of synergistic effects, dose rate effects, and oxygen diffusion effects;
- double peak requirement;
- radiation testing and source term considerations;
- EQ boundary restrictions that make it difficult if not impossible to perform maintenance and replacement activities;
- schedular constraints for performing maintenance and replacement of EQ equipment (i.e., no grace period allowed); and
- documentation requirements.

The NRC staff did not consider any of the EQ methodology issues to be immediate safety problems.

C. Current Status and Implementation of EQ Requirements

1. It is difficult to determine what minimum EQ standard was imposed on licensees because a clear record of exceptions that were allowed by the staff is not readily available. The matter is further complicated by the evolving nature of requirements that were being promulgated by IE Bulletins, Supplements, and ultimately by the EQ rule. The following problem statements relate to this issue:

Peer Review Comments:

a. In reviewing the concern and the following problem statements presented in support this issue, I would be remiss if I did not point out that they reflect a compilation by one or many who were not involved in EQ in the early days, and thus are unfamiliar with the rationale for why somethings are the way they are. It is understandable that there is a sense of frustration when one does not know the basis for a decision, and cannot readily find i .

I agree that in looking back, one can come up with a need for more and better documentation of the bases for many of the decisions that were made. Is this not true of any human activity? This will be all the more true if that activity involves an attempt at backfitting operating plants, and plants under various stages of construction, to meet requirements based on an evolving technology. I think that we should be able to say enough is enough and move on to the more important items.

If one wants to reconstruct events and bases for the many decisions that were made by the NRC headquarters staff and the field inspection teams, it can be done. It will be a time consuming project and a costly effort. It will require the participation of people from the NRC and the industry who were involved in those days. Luckily, we still have about a dozen of them actively involved in the industry or in the NRC, although they may not be in the same technical areas.

b. There has been clarification but there are no exceptions to the DOR Guidelines. IE Bulletins and their Supplements require responses to specific issues. Therefore, if one has all the Bulletins and their Supplements, there should not be any confusion as to the requirements of the Bulletin. However, if any such confusion exists, the NRC staff is available to discuss specific issues.

Staff Comments:

Based on the staff's review under EQ-TAP Action Item 3.e [10], it appears that the requirements and implementation of EQ requirements were consistently established and well assured. Resolution of the more trivial, administrative deficiencies that were discovered during the NRC staff review and inspection process was accomplished through meetings that were conducted between the NRC staff and each licensee. Given the

very large number of deficiencies that was typical of this process, only those considered to be of significance were documented in the meeting minutes. The less significant items were [illegible]ed by the applicable licensee as needing to be corrected. While the less significant EQ deficiencies may not have been documented, it is the staff's view that this does not represent a significant compromise of EQ requirements.

- It is not clear to what extent the various clarifications and staff positions that were stated in Generic Letters, IE Bulletins, Appendix B of NUREG-0737, etc., were fully implemented, and which ones are currently applicable since they are not specifically referred to by 10 CFR 50.49.

Peer Review Comments:

a. I agree.

b. Merits analytical resolution. It seems reasonable to expect the NRC to clear this up.

c. All clarifications, staff positions, Generic Letters, IE Bulletins, and Appendix B of NUREG-0737 were fully implemented. The ones that are currently applicable requires a reading of the document in question.

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], what was required to be implemented in the way of EQ requirements was pretty clear. In general, requirements that were established by Generic Letters and Bulletins are still applicable unless they have been superseded by more recent requirements. However, given the rapid development and transition of EQ requirements, the staff may not have been entirely clear as to what was being "superseded" and there may be some confusion in the industry on this point. Therefore, the NRC staff should pursue this matter with industry representatives to determine whether clarification of the existing requirements is necessary.

- Emergency shutdown systems "...used to bring the plant to a cold shutdown condition following accidents which do not result in a breach of the reactor coolant pressure boundary together with a rapid depressurization of the reactor coolant system" were required to be qualified by plants subject to the DOR Guidelines. It is not clear, however, that this was the case for NUREG-0588 plants. Also, since qualification of cold shutdown equipment was not required by the EQ rule, it is not clear to what extent this requirement is currently valid.

Peer Review Comments:

a. I am not aware of this issue.

b. Plant-specific design bases.

c. Merits analytical resolution. Although this reviewer is not knowledgeable about this issue, the statement itself seems to justify a response.

d. Currently, plants are required to qualify a path to safe shutdown. Safe shutdown is not defined the same way for all plants (i.e., some plants define safe shutdown as hot shutdown). Plants must qualify a path to cold shutdown only if their license defines safe shutdown as "cold shutdown." This situation applies to all plants (i.e., DOR Guidelines, NUREG-0588 Categories I and II).

Staff Assessment:

See the staff assessment of the previous problem statement.

Evidently, the NRC staff considered certain parts of the DOR Guidelines and NUREG-0588 to be "optional" and consequently, the minimum standards that were found to be acceptable to the staff are not well defined. Exceptions that were allowed to EQ requirements may not have been proper and consistent in all cases.

Peer Review Comments:

a. I am not aware of this issue.

b. Merits analytical resolution. It seems reasonable to expect the NRC to clear up this issue.

c. None of the requirements were optional. However, there may be optional ways to comply with a particular requirement. There was no NRC policy that allowed for exceptions within a review category without approval by the NRC Commissioners themselves. The intentional differences in the NRC staff policy are those that places plants into the three categories to be reviewed under the DOR Guidelines, NUREG-0588 category II and NUREG-0588 category I. Nevertheless, NRC inspectors may differ somewhat in their determination of what is acceptable to meet a particular requirement. However, these differences should be within the range of the "slight differences" that we all experience in the way we see things, or there may be some differences that were unintentional and can be attributed to a mistake by a particular inspector.

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], this does not appear to be a valid issue. The process that was used by the staff for evaluating licensee compliance with EQ requirements was quite rigorous and well defined. While resolution of many of the less significant, plant-specific issues may not have been well documented, but the process was consistent and involved the same principal NRC participants which would tend to minimize inconsistencies.

- During the NRC's EQ inspection activities of the mid-1980s, inconsistencies existed in the staff's interpretation of EQ requirements and test results.

Peer Review Comments:

a. Region 3 attempted to implement a consistent interpretation of EQ requirements during the inspections in question. This was accomplished through the use of a common pool of contractors, frequent discussions with NRR on evolving EQ issues and the attendance of all available EQ training opportunities and meetings.

b. Merits analytical resolution. It seems reasonable to expect the NRC to clear this up.

c. Inconsistencies that may exist are not the result of NRC policy; but rather, are unintentional errors on the part of the inspector(s).

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], this does not appear to be a valid issue. While some inconsistencies were inevitable due to the different knowledge and experience levels of the various NRC inspectors involved, workshops were held with the Regions and with the licensees to minimize the extent of this problem. The NRC Headquarters Office was also actively involved in training the inspectors, providing guidance, and addressing issues that were identified, which also helped to achieve a consistent application of the requirements.

- Crediting EQ tests of commercial or generically named components may not have been entirely appropriate when these tests covered various manufacturers, vintages, or designs of cables and interfacing components.

Peer Review Comments:

a. I believe that the generic tests were proven to be acceptable for specific components by carefully reviewing the tests and assuring the results bounded the component in question.

b. I don't think that this was done.

c. I agree, but the statement is too mild.

d. I agree that EQ tests should not be extrapolated to commercial or generically named components. The regulations and IEEE 323-1974 require that the link between the qualified test specimen and the items in the plant, including manufacturer, model and vintage be established. If similarity of the test specimen to the plant installed equipment was not established, then installed equipment was judged to be not qualified.

e. More NRC oversight may be needed; this is a valid concern to the extent that any qualification program does not satisfy qualification requirements concerning the choice of test specimen and the extrapolation of tests to similar components.

f. I am unaware of such crediting of EQ tests. When did this happen? It is entirely inappropriate.

Staff Assessment:

There may have been circumstances where this practice was considered to be appropriate. For example, this may have been allowed for equipment qualification under the DOR Guidelines. To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information, this issue becomes one of minor importance with regard to aging considerations. However, irrespective of aging considerations, there could be some question as to whether "generic qualification" was sufficient to demonstrate that equipment will function during an event. The NRC staff should determine whether any additional action is warranted to address this issue based on the information that has been accumulated over the past 25 years.

All test failures (for all attempted EQ tests) were not specifically required to be documented, evaluated, and saved as part of the equipment qualification record and consequently, qualification may not have been totally objective (i.e., EQ may have been based on "selective" information).

Peer Review Comments:

a. This may be true to some extent, but it is believed that the vast amount of test data that was reviewed satisfactorily demonstrated qualification including explanations of test failures.

b. In EQ testing, most test programs were performed with a minimum of anomalies and all anomalies including equipment corrective actions and retesting are documented. Since it is necessary to demonstrate a clear path of successful operation, when test failures resulted in substantial redesigns, some vendors chose to redesign and then start the qualification process on new designed equipment. Thus, not all test failures were passed along to the licensees. The process was objective in that a clear path of proper performance was necessary to be documented.

c. More NRC oversight may be needed. Although the NRC did address this issue in some of its EQ inspections, it is possible that the problem was not corrected in all cases. The statement of the issue is consistent with this reviewer's experience with qualification testing and documentation and his participation in EQ inspections; and he agrees therefore that it is a valid concern.

d. Perhaps this statement is true. However, requirements for reporting test failures are governed by 10 CFR Part 21, "Reporting of Defects and Noncompliance." Any test failures that fall within the scope of 10 CFR Part 21 should have been reported in accordance with its provisions. Otherwise, the testing entity would be in violation of the Code of Federal Regulations.

Staff Assessment:

The results of past research efforts should be catalogued and the information should be well understood and related to specific equipment applications in order to address issues such as this one. The staff should also assure that full advantage is taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may currently exist. The NRC staff should provide additional guidance if necessary to ensure that current EQ testing practices are appropriate.

Non-safety-related instruments that could impact the operability of safety-related instruments were not initially included in the scope of equipment that was required to be qualified, and implementation of this requirement may not be uniform among all plants.

Peer Review Comments:

a. I am not aware that this is an issue.

b. Point Beach was the pilot plant; all plants were similarly addressed by the EQ Branch.

c. The inclusion of non-safety equipment that could impact safety equipment is a requirement of all EQ programs per 10CFR50.49. All plants had to have safety evaluations for 10CFR 50.49. Thus, this should have been addressed for all plants. This type of equipment was addressed at all of the EQ audits of which I was aware.

d. More NRC oversight may be needed.

e. This statement may be true. However, it is not consistent with the intent of qualification criteria initially set forth by the NRC staff. For example, IE Bulletin 79-01B dated January 14, 1980, stated in the second paragraph of item 1 under "Action To Be Taken By Licensees Of All Power Reactor Facilities With A Operating License (Except those 11 SEP Plants Listed on Enclosure 1)" that "Electrical equipment items, which are components of systems listed in Appendix A of Enclosure 4, which are assumed to operate in the FSAR safety analysis and are relied on to mitigate design basis events are considered within the scope of this Bulletin, regardless whether or not they were classified as part of the engineered safety features when the plant was originally licensed to operate. The necessity for further up grading of non-

safety-related plant systems will be dependent of the outcome of the licensees and NRC reviews subsequent to TMI/2." As a result of the EQ rule, plants are required to address this issue under 10 CFR 50.49(b)(2). As indicated above, the requirement to address this issue may not have been as clear at the time of issuance of IE Bulletin 79-01B as it was when the EQ rule was issued. Nevertheless, this is a safety issue and all plants should address this issue as required to insure safety and safe shutdown in the event of a design basis accident.

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], this does not appear to be a valid issue. Instrumentation was included in the NRC review and inspection of licensee implementation of EQ requirements for all plants. The process appeared to be rigorous and comprehensive, it appeared to be consistent for all plants.

- RG 1.97 instruments were not addressed in the initial qualification requirements and it is not clear to what extent (and to what criteria) instruments were required to be qualified.

Peer Review Comments:

a. It should be clear now.

b. Merits analytical resolution (i.e., analyze existing data to reach resolution).

c. The guidance provided in RG 1.97 Revision 2, dated December 1980, can be traced to NUREG-0737, published November 1980, entitled "Clarification of TMI Action Plan Requirements," and to NUREG-0737 Supplement No. 1, dated December 17, 1982. NUREG-0737 and its supplement contained letters that issued these documents as requirements, rather than just NUREGs. Subsequent to the issuance of NUREG-0737, NUREG-0737 Supplement 1, and RG 1.97, the NRC staff met with all licensees and discussed qualification requirements and implementation dates as related to RG 1.97. The NRC staff subsequently wrote safety evaluation reports documenting the results of the meetings and the RG 1.97 qualification requirements for all plants. Those requirements apply to all plants and are the same as the requirements of 10 CFR 50.49(b)(3) which represents the criteria for all plants. There were however, plant specific exceptions to this criteria. The exceptions were based primarily on differences in plant design which could affect the requirement(s) for a particular instrument.

Staff Assessment:

See the staff assessment of the previous problem statement.

- Requirements for protection from "control system interactions" may not be uniform for all plants.

Peer Review Comments:

a. I am not aware of this issue.

b. Merits analytical resolution (i.e., analyze existing data to reach resolution).

c. This statement is not completely clear. However, if "control system interactions" is the same as Task Action Plan Item A-17, "Systems Interactions In Nuclear Power Plants," see the staff resolution of Item A-17 contained in NUREG-0933.

Staff Assessment:

See the staff assessment of the two previous problem statements.

2. The EQ inspections of the mid-1980s found that many programs lacked the documentation necessary to support EQ inspection activities, especially at the older plants. Without sufficient documentation, it is doubtful that qualification was truly established at these facilities.

Peer Review Comments:

a. I disagree, since these findings were not dropped and licensee actions to demonstrate qualification were required.

b. I disagree, sounds like an education problem. Are not the NRC audits and the findings therefrom usually closed out by follow-up inspections or written responses from the licensees?

c. It was my understanding that EQ open items, such as EQ deficiencies found during the EQ audits of the mid-1980s, were required follow-up items by NRC Regional Offices.

d. More NRC oversight may be needed.

e. The NRC staff audited the EQ programs at all nuclear power plants and issued violations and, when appropriate, fines when it was determined that qualification could not be demonstrated at a given facility. However, the qualification standards that were applied to older plants are different from those that were applied to newer plants. For example, the DOR Guidelines are somewhat different from the NUREG-0588 Category I requirements. Differences in qualification requirements other than those that result from differences in regulations should not exist, and if such differences do exist, it is a mistake. If documentation at any plant is insufficient to establish qualification, that is also a mistake. All operating plants should have sufficient documentation to demonstrate that all equipment required to be qualified is qualified. If such documentation does not exist for a given plant, then that plant is violating both the law and it's intent. In addition, such plants should also be considered to be unsafe.

Staff Assessment:

Based on the staff's review under EQ-TAP Action Item 3.e [10], this does not appear to be a valid issue. The staff agrees with the view (stated above) that the findings were not dropped and licensee action was required to resolve documentation problems.

3. Given the evolving nature of EQ and the confusion that existed in the industry, licensee QA programs may not have been well structured and focused on implementing EQ requirements.

Peer Review Comments:

a. I agree.

b. To some extent, this may have been true during the early stages of EQ implementation. The situation has long since been corrected, and to the best of my knowledge, the industry QA/QC programs do reflect sensitivity to EQ requirements. In fact, the industry now performs self assessments, and/or periodic EQ audits of their own programs, and vendor surveillances to verify continued attention to quality in this area. This combined with ongoing staff training performed by the industry should alleviate this concern.

c. Licensee QA personnel were integral team members in the EQ process and judging that QA audits were regularly performed at the laboratories, I believe that they were fully integrated into the EQ process all along.

d. This statement may be true. However, EQ requirements were established in the early 1980s (approximately 15 years ago), and any confusion that existed early in this time frame should have been cleared up by now. However, should confusion continue to exist, the NRC staff is available for discussion and clarification as needed. Environmental qualification programs at plants are, and should be, living programs (i.e., programs should be updated as new information becomes available) and when licensees find mistakes, the NRC expects licensees to correct those mistakes. By the way, licensees can update EQ programs and correct mistakes without being issued violations or fines.

Staff Assessment:

The staff agrees with the view (stated above) that to the extent that this problem did exist during the early stages, it has long since been corrected. In order to account for any lapses that may have occurred during the initial implementation of EQ requirements, the NRC staff should assure that full advantage is taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may currently exist.

Summary

Based on the staff's review of current status and implementation issues, the following recommendations were made:

a. Given the rapid development and transition of EQ requirements, the staff may not have been entirely clear as to what was being "superseded" and there may be some confusion in the industry on this point. Therefore, the NRC staff should pursue this matter with industry representatives to determine whether clarification of the existing requirements is necessary.

b. There could be some question as to whether "generic qualification" was sufficient to demonstrate that specific equipment will function during an event. The NRC staff should determine whether any additional action is currently warranted to address this issue based on the information that has been accumulated over the past 25 years.

c. The results of past research efforts should be catalogued and the information should be well understood and related to specific equipment applications in order to address issues such as: (a) implications of EQ test failures, and (b) lapses that may have occurred during the initial implementation of EQ program requirements. The staff should also assure that full advantage is taken of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ-related deficiencies that may exist on an ongoing basis. The NRC staff should provide additional guidance if necessary to assure that current EQ testing and QA practices are appropriate.

The NRC staff did not consider any of the current status/implementation issues to be immediate safety problems.

D. Assurance of Continued Qualification

1. Existing programs have not been developed and implemented to assure continued equipment qualification, including qualification beyond the established "qualified life." The following problem statements relate to this issue:

Peer Review Comments:

a. I agree that continued qualification has been fumbled by the NRC. I remember a spring 1980 meeting where the EDO expressed great concern on this very point, but the EDO and NRC management's interests were diverted to other more immediate issues.

b. I disagree. The industry is keenly aware of the need to assure the continued validity of the qualification that has been established, and have implemented programs accordingly. Again, this is an area where one can find varying methods and levels of details. Many of the problem statements listed to support this contention are just not valid. I would be remiss if I did not point out that they do reflect a level of unfamiliarity with the industry programs in this area.

If there is anything that the NRC could do in this area, it is the development of a guide based on a survey of the current practices. Such a guide will go a long way toward promoting uniformity of industry practices. It may be argued that developing such a guide is inconsistent with the NRC Mission. Perhaps a justification can be found under the need to improve consistency in inspection practices, and to reduce the cost burden imposed by the EQ regulation.

c. The awareness of the significance to EQ of Component Root Cause Failure Analyses, information provided in NRC Notices and Bulletins, and realization that unexpected degradation impacts EQ is generally present at licensees. The re-emphasis by the NRC of EQ awareness would probably be appropriate.

d. This statement is incorrect. In all plants, there is equipment that is not qualified for the forty (40) year life of the plant. It is well known throughout industry that when a piece of equipment reaches the end of its qualified life, it should be replaced or requalified. If equipment is not being replaced as it reaches the end of its qualified life, then the EQ program reviewed and approved by the NRC is not being followed and the plant should be issued a violation for being unsafe and not in compliance with the requirements of 10 CFR 50.49.

Staff Assessment:

For whatever reason, the NRC staff never really got around to establishing guidance for maintaining continued (ongoing) qualification of equipment, other than the "replace or requalify" aspect discussed in

the peer review comments (above). Essentially by default, the staff accepted conventional maintenance and surveillance practices and requirements for serving this function, and no initiatives were pursued for developing further guidance in this area. Shortcomings and uncertainties that exist in the EQ methodology (see Section B of this appendix) indicate that additional measures are needed to assure continued equipment qualification over the life of the plant. While the staff agrees with the views (stated above) that a re-emphasis of EQ awareness and promulgating guidance based on current industry practices would be helpful, a more extensive effort is needed. In particular, the staff should assure that operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information are used in a comprehensive manner in order to maintain EQ over the life of the plant. Further, the staff's guidance should not necessarily be limited to "current practices." Implementation of the maintenance rule should help to address this concern for active components, and the staff should initiate action to include passive electrical equipment within the scope of the maintenance rule for EQ considerations.

The DOR Guidelines state that ongoing programs should exist to review surveillance and maintenance records to assure that equipment that exhibits degradation (e.g cables) will be identified and addressed as necessary. Programs such as these are generally not in place.

Peer Review Comments:

a. I believe we accepted normal surveillance and maintenance programs as being acceptable to meet this requirement. These programs should still be acceptable.

b. They should be.

c. Merits analytical resolution (i.e., analyze existing information to reach resolution). The following additional views were also expressed in response to other related issues and problem statements:

- A tightening of EQ, surveillance, and maintenance requirements can help assure that adequate attention is given to worst case conditions.

- Where experience predicts that certain equipment in certain locations is expected to be subject to steam leaks and inadvertent spray actuations, the EQ program should incorporate testing (such as humidity stress tests) to simulate these service conditions. Where such events were not anticipated in the EQ program, the existing program should be supplemented by additional testing or enhanced condition monitoring to assure that equipment is refurbished or replaced when it is no longer able to operate as required during a DBA.

There is now a need to evaluate alternatives to the qualified life requirement. Operating experience and enhanced condition monitoring are among the alternatives that should be considered.

Staff Assessment:

See the previous staff assessment.

- Licensee QA programs may not be well focused on maintaining EQ requirements. For example, analyses performed by licensees (e.g., 50.59 reviews, root cause, corrective action, etc.) may not be well focused in this regard.

Peer Review Comments:

a. There is no evidence of this at this time.

b. If licensees are not maintaining EQ programs as required by the Code of Federal Regulations, then those licensees are in violation of requirements and such violations should be reported to the NRC.

Staff Assessment:

See the staff assessment following D.1 (above).

- Changes in manufacturing techniques and use of materials when refurbishing equipment may not be adequately addressed by the original equipment qualification documentation.

Peer Review Comments:

a. This could be true.

b. Industry responsibility; more NRC oversight may be needed. It is the industry's responsibility to account for significant differences between the materials and parts used in the refurbished equipment and the materials and parts in the equipment that was qualified. More oversight may be needed to assure that qualification programs account for such differences.

c. If not adequately addressed, it should be. Again, EQ should be a living program. If licensees discover that an EQ program or some parts of an EQ program is inadequate, that licensee should take corrective action without being forced to do so by the NRC.

Staff Assessment:

The staff agrees with the view (stated above) that it is the licensee's responsibility to assure that replacement and refurbished or repaired equipment is adequately qualified, and guidance for addressing this concern would be best addressed as an industry initiative.

- Purchase specification requirements for replacement parts have not been addressed relative to EQ.

Peer Review Comments:

a. I seem to remember they were addressed in that replacement equipment was required to meet Category I requirements.

b. Have not been addressed by whom? This issue is addressed in RG 1.89 paragraph C.6, and in 10 CFR 50.49(l).

Staff Assessment:

While the requirements are relatively clear for instances where complete components are being replaced, the requirements are not so clear when piece parts of qualified components must be replaced. See the staff assessment of the previous problem statement.

- Criteria for acceptable versus unacceptable aging degradation have not been established.

Peer Review Comments:

a. If this concerns life extension, this may be true.

b. I do not agree.

c. This statement is true only for equipment that was not preaged. For this equipment, licensees must determine the limit to which a piece of equipment can be degraded and yet perform its required action when called upon. To date, the NRC has left this determination to the licensees. For preaged equipment, the equipment is preaged to the end of qualified before design basis accident testing. If unacceptable aging occurs (i.e., aging not in accordance with preaging testing and analysis), then the preaging environment was incorrectly determined. In this event, the preaging analysis and testing should be revisited and the qualified life should be adjusted in accordance with the results of the revisit.

Staff Assessment:

This is a valid concern. The staff has relied primarily on initial qualification testing as a means to establish EQ, but focused attention has not been provided on maintaining equipment qualification over the life of the plant. See the staff assessment following D.1 (above).

- The effects of installation, maintenance and surveillance practices on equipment qualification have not been addressed.

Peer Review Comments:

a. I see no evidence of this at this time.

b. Industry responsibility; merits analytical resolution. The effects of installation, maintenance, and surveillance practices have been addressed only cursorily in industry standards and regulatory guidance. While it is the industry's responsibility to account for these effects, it would be helpful if the NRC provided more detailed guidance than is currently available.

c. The installation, surveillance, and maintenance of equipment is the sole responsibility of licensees. To the extent these practices need to be addressed, they must be addressed by licensees.

Staff Assessment:

The staff agrees with the view (stated above) that if it has been addressed at all, it has been done in a very cursory manner. See the staff assessment following D.1 (above).

Identification and treatment of hot spots, long overhangs, insulation and jacket embrittlement, unintended long-term submergence, exposure to chemical attack (e.g., boric acid leakage, decontamination activities), and localized anomalies have not been addressed

Peer Review Comments:

a. I see no evidence of this at this time. Hot spots, when identified, are addressed by licensees. So are the other conditions.

b. Industry responsibility; merits analytical resolution. The issue raised by this statement is similar to the one in the preceding statement. The industry is aware of the need to account for these effects to assure plant safety, but prescriptive methods of doing so are not available. The items named in this statement can be regarded as weak links in safety systems, as they may be more likely to cause failure than the degradation of equipment in normal environments. Consequently, their importance cannot be overamphasized. However, since they are deviations from the conditions planned to exist in nuclear plants and can have many individual variations, it is not feasible to develop detailed procedures for dealing with them. Nonetheless, it may be possible to provide some broad guidelines.

c. EQ programs as envision by the NRC and industry should be set-up to be continuously updated so as to be able to address these issues if and when they occur. That is what is meant when EQ programs are referred to as living programs. It is the responsibility of licensees to update and maintain EQ programs as required to ensure qualification; this includes identification and treatment of hot spots, long overhangs, insulation and jacket embrittlement, unintended long-term submergence, exposure to chemical attack, etc.

Staff Assessment:

The staff agrees with the view (stated above) that the importance of this concern cannot be overemphasized, and guidance is needed. See the staff assessment following D.1 (above).

- Maintenance and inspection activities have not been developed and implemented to assist in the aging management of EQ components.

Peer Review Comments:

a. I see no evidence of this at this time.

b. This statement will certainly apply to plants that do not have an acceptable surveillance and maintenance program. One of the primary parts of an acceptable EQ program is a comprehensive surveillance and maintenance program. Plants without acceptable surveillance and maintenance programs do not have acceptable EQ programs. I would like to emphasize here that surveillance and maintenance is a major part of EQ and must be performed by the licensees throughout the life of the plant.

c. Industry responsibility. The following additional views were also expressed in response to other related issues and problem statements:

   - A tightening of EQ, surveillance, and maintenance requirements can help assure that adequate attention is given to worst case conditions.

   - Where experience predicts that certain equipment in certain locations is expected to be subject to steam leaks and inadvertent spray actuations, the EQ program should incorporate testing (such as humidity stress tests) to simulate these service conditions. Where such events were not anticipated in the EQ program, the existing program should be supplemented by additional testing or enhanced condition monitoring to assure that equipment is refurbished or replaced when it is no longer able to operate as required during a DBA.

   - There is now a need to evaluate alternatives to the qualified life requirement. Operating experience and enhanced condition monitoring are among the alternatives that should be considered.

Staff Assessment:

This is a valid concern. The staff has relied primarily on initial qualification testing as a means to establish EQ, but focused attention has not been provided on maintaining equipment qualification over the life of the plant. See the staff assessment following D.1 (above).

2. Condition monitoring techniques have not been sufficiently developed to project remaining service life.

Peer Review Comments:

a. I am not aware that condition monitoring is used to determine remaining service life.

b. I agree. This is well recognized by the NRC and the industry. Ongoing research can be effective in this area if it is better focused. By this I mean laying it out as a long range (5 to 10 yrs) program and progressing in small manageable chunks. A PSA based equipment prioritization would be of great help in this regard.

c. It is already accepted practice to calculate qualified life from assumed ambient temperatures and to establish actual ambient temperatures. Thus, the use of Condition Monitoring techniques, such as Infrared Thermography and vibration signatures, are a natural extension to establishing remaining lives for most equipment. The condition of equipment temperature has been shown to be one of the most significant parameters at detecting age related degradation in NUREG/CR-5762.

d. Merits experimental research. The condition monitoring component of the NRC research plan has the greatest potential for benefiting the nuclear industry.

e. This is correct.

Staff Assessment:

The staff agrees with the views (stated above) that research in this area can be effective if better focused and that this aspect of the NRC research plan has the greatest potential for benefiting the nuclear industry. It would be unrealistic to believe that condition monitoring techniques can be developed to project remaining service life with any degree of accuracy, but condition monitoring techniques can be developed and used to provide assurance that equipment has not degraded beyond some pre-defined acceptable level. Also, condition monitoring programs can best be developed and implemented as a cooperative effort with full industry participation. Over the next several years, the NRC staff should develop, in concert with industry, guidance for the mandatory application of condition monitoring techniques in order to assure continued equipment qualification over its installed lifetime. This is a part of the more comprehensive effort that is needed to maintain equipment qualification (see the staff assessment following D.1. above).

3. EQ requirements for replacement equipment should be better defined and justified. The following problem statements relate to this issue:

Peer Review Comments:

a. I disagree. Much has been done in this area both by the NRC and by the industry. It is time to let the industry fine tune their programs. This area requires continued vigilance on the part of the NRC and industry. That is the nature of beast. It should also be pointed out that some of the problem statements listed below reflect a level of unfamiliarity with the issues.

Staff Assessment:

Since several different standards were allowed for initial equipment qualification, depending on plant vintage, 10 CFR 50.49 (the EQ rule) included provisions for upgrading replacement equipment to the more rigorous requirements of the rule. Since a transition period was necessary for upgrading replacement equipment to minimize the impact on operating reactors, "reasons to the contrary" appropriate for the transition process were established by the NRC staff and included in Regulatory Guide 1.89. Unfortunately, guidance was not provided for how long this transition period should be and more appropriate "reasons to the contrary" have not been established given that ample time has been allowed for the "transition process" to be completed. To the extent that it is truly necessary to upgrade to the more rigorous EQ requirements, more appropriate "reasons to the contrary" should be established. However, as discussed in Section B of this appendix, some changes in the methodology for establishing initial equipment qualification may be possible that could be of benefit to the industry. This is especially true recognizing that ongoing measures must be developed and implemented to assure continued qualification over the installed lifetime of the equipment (see the staff assessment following D.1, above). Therefore, resolution of this concern should be coordinated with industry initiatives to improve the EQ process.

"Reasons to the contrary" for not upgrading replacement equipment to the requirements stated by 10 CFR 50.49 appear to be without merit and should be justified.

Peer Review Comments:

a. I am not aware of this issue.

b. Several "sound reasons" were listed in a 1982 (?) Generic Letter signed by Eisenhut. Licensees were encouraged to develop others where necessary.

c. "Sound reasons to the Contrary" are probably antiquated and should be dropped. The more common practice of upgrading replacement equipment has been in effect since 1983.

d. Perhaps, but a reading of the reasons to the contrary as outlined in RG 1.89 seems to suggest that economics is involved and technical justification may be somewhat elusive.

Staff Assessment:

See the staff assessment of the previous problem statement (above).

- Equipment that is qualified to the DOR Guidelines and is well suited for its application must be replaced with NUREG-0588 Category I equipment regardless of whether the upgraded equipment can perform the desired function as well as the older equipment.

Peer Review Comments:

a. I agree.

b. Is this true? I thought "sound reasons" applied. It certainly should -- replacing equipment with a different type often creates problems that we don't want or need.

c. This statement is not correct (see Regulatory Guide 1.89 Rev 1, Regulatory Position C.6). In addition, since replacement equipment is more rigorously tested than DOR Guidelines equipment, how can it be shown that DOR Guidelines equipment is better suited for a particular application? If a particular item is performing a given function and it is replaced with an item that cannot reliably perform that function, then this is not considered to be an upgrade.

Staff Assessment:

The real problem here is that, to the extent that this situation exists, licensees have not planned for the eventual replacement of plant equipment and have not taken the necessary steps to qualify equipment to the more rigorous requirements. This problem is best resolved by the industry. Also, see the staff assessment following D.3 (above).

- The requirement to upgrade equipment from Category II to the Category I criteria of NUREG-0588 is prohibitive and provides no safety benefit, especially if the installed equipment has been preaged and all that is missing is the Category I documentation.

Peer Review Comments:

a. If this is true, the requirement should be relaxed.

b. Apart from my concern about "sound reasons," I don't understand the last line -- does it mean that DOR level documentation is available?

c. For equipment to be certified as NUREG-0588 Category I or 10 CFR 50.49 qualified, required more than just pre-aging. Category I and 10 CFR 50.49 certification requires better and more complete documentation of performance characteristics during the harsh environment. Thus, equipment which was pre-aged, but was lacking in current practices of documentation, has been certified to meeting Category II or DOR Guidelines requirements.

d. Industry responsibility, merits analytical resolution. If "all that is missing is the Category I documentation," it is not

obvious why the existing documentation cannot be upgraded. However, if the existing qualification program does not meet the more demanding requirements of NUREG-0588, Category I, it cannot be concluded that ungrading from Category II to Category I is always "prohibitive and provides no safety benefit." On the other hand, upgrading the qualification is not necessarily the only way to provide reasonable assurance of equipment operability. In certain cases, increased surveillance, condition monitoring, and operating experience may be acceptable alternatives.

e. Exactly what documentation is missing from the file of this equipment? Has this item been preaged only, or has it been preaged and LOCA tested? If it has been preaged only then it is quite obvious that required performance in a DBA has not been demonstrated, and this condition is and should be unacceptable. If an item is not tested, how can reliable performance in a DBA be assured?

Staff Assessment:

The staff agrees with the views (stated above) that Category I qualification requires more than just preaging, and that upgrading qualification is not necessarily the only way to provide reasonable assurance that equipment will function during an event. As discussed in Section B of this appendix, some changes in the methodology for establishing initial equipment qualification may be possible that could be of benefit to the industry. This is especially true recognizing that ongoing measures must be developed and implemented to assure continued qualification over the installed lifetime of the equipment (see the staff assessment following D.1, above). Therefore, to the extent that this concern represents a significant problem for licensees, resolution should be pursued as an industry initiative.

- There is decreasing support and cooperation from vendors of qualified equipment. Some original EQ equipment suppliers are no longer available to provide qualified replacement equipment. Third-party vendors will supply qualified equipment, but costs tend to be excessive.

Peer Review Comments:

a. Third party dedicators? Quality may be suspect, also.

b. Industry responsibility.

c. I believe this statement is correct, but that is the reality of the market place. It is not acceptable to compromise the safety of a plant by using equipment not qualified to perform required functions when called upon.

Staff Assessment:

The staff agrees with the view (stated above) that resolution of this concern is industry responsibility. However, as discussed in Section B

of this appendix, changes may be possible in the EQ methodology that may help to alleviate this concern. The NRC staff should be receptive to such proposed changes that are: (a) developed as an industry initiative, and (b) technically justified.

4. Tight budgeting continues to be a challenge to any advancements in the area of EQ.

Peer Review Comments:

a. I agree, and that is the real world. I know many cases where advancements have been or are being made despite this constraint. I believe that time and market forces will take care of this.

b. Merits analytical resolution. The suggestions (made in response to other issues and problem statements) that EQ requirements be reviewed in light of the experience of the last two decades has the prospect of increasing the assurance of safety and reducing EQ costs. For example, if the qualified life requirement were replaced by standardized stress testing, it could reduce costs significantly.

Staff Assessment:

The NRC staff agrees with the view (stated above) that a review and adjustment of the EQ requirements in light of the experience and information that has been gained over the last two decades has the prospect of increasing the assurance of safety and reducing EQ costs. However, resolution of this concern is industry responsibility and should be pursued as an industry initiative with full NRC staff cooperation.

Summary

Based on the staff's review relative to assurance of continued qualification, the following recommendations were made:

a. While the NRC staff agrees with the peer review comments that a re-emphasis of EQ awareness and promulgation of guidance based on current industry practices would be helpful, a more extensive effort is needed. In particular, the staff should assure that operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information are used in a comprehensive manner in order to maintain EQ over the life of the plant. Further, the staff's guidance should not necessarily be limited to "current practices." This approach would be useful in addressing current concerns such as installation, maintenance, and surveillance effects; hot spots; long overhangs; aging degradation; etc.

b. Implementation of the maintenance rule should help to assure continued equipment qualification over the useful life of each active item that is qualified, and the staff should initiate action to include passive electrical equipment within the scope of the maintenance rule to better assure continued qualification of electrical equipment.

c. Over the next several years, the NRC staff should develop, in concert with industry, guidance for the mandatory application of condition monitoring techniques in order to assure continued equipment qualification over its installed lifetime. This is a part of the more comprehensiv effort discussed in (a) above, that is needed to maintain equipment qualification.

d. To the extent that it is truly necessary to upgrade to the more rigorous EQ requirements, more appropriate "reasons to the contrary" should be established. However, as discussed in Section B of this appendix, some changes in the methodology for establishing initial equipment qualification may be possible that could be of benefit to the industry. This is especially true recognizing that ongoing measures must be developed and implemented to assure continued qualification over the installed lifetime of the equipment (see (c) above). Therefore, resolution of this concern should be coordinated with industry initiatives to improve the EQ process.

e. The NRC staff agrees with the peer review comments that a review and adjustment of the EQ requirements in light of the experience and information that has been gained over the last two decades has the prospect of increasing the assurance of safety and reducing EQ costs. However, resolution of this concern is industry responsibility and should be pursued as an industry initiative with full NRC staff cooperation.

The NRC staff did not consider any of the issues pertaining to assurance of continued qualification to be immediate safety problems.

E. Equipment-Related Issues

1. Failure of other electrical components such as penetrations and connector assemblies may be more important than the failure of electrical cables, and more attention may be warranted for these components.

Peer Review Comments:

a. Both failures could be extremely detrimental for plant response to a DBE, so the issue of more significance/consideration for one failure versus the other escapes me.

b. Operating reactor inspections concentrated on non-cables.

c. Depending upon one's perspective, a case can be made for one or more component(s) as more important than others. I do believe that the focus on cables is correct and should be continued. Decisions relating to the importance can probably be best addressed if we complete a PSA of EQ priorities as discussed elsewhere in this document. A few guiding factors in establishing such importance rankings include:

- maintenance and surveillance being performed on the items of interest;
- potential for as yet unaddressed or unmanifested common cause failure mechanisms;
- cost to replace, particularly during an extended license term;
- potential for causing multiple system and component failures simultaneously; and
- last, but not least, failure experience.

d. What does "more important" mean? Risk impact, higher failure rate?

e. Judging from the failures noted in BNL's review of LER's and NRC's Notices and Bulletins, connections and penetrations may be experiencing more aging degradation than cables and thus would warrant additional attention.

f. Merits analytical resolution. A valid concern because it is possible that the failure rates of connectors and penetration assemblies exceed that of cables.

g. First of all, all equipment within the scope of the EQ rule is important, as is indicated by its title, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants." The NRC expects licensees to use good

engineering judgement when making equipment operability decisions, and decisions involving the operation of plants in general. As for this particular situation, although electrical penetrations and connector assemblies are important, they will not function without the cables that transmits power to them.

Staff Assessment:

Based on the peer review comments (above), the specific concern regarding electrical penetrations and connector assemblies is a valid one and further action by the NRC staff is warranted to resolve this issue. This concern should be reviewed in light of the ongoing literature survey that is being done under contract for the NRC to determine to what extent a significant problem may exist. Corrective action should be taken depending on the nature of the deficiencies that are identified (should any exist). Beyond this, focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct EQ deficiencies (see Section A and Section B of this appendix), will help to address this concern on an ongoing basis. The staff agrees with the peer review comments that an importance ranking may be appropriate given operating plant experience (i.e., equipment failure data) and PRA information.

2. Moisture transmission through cracks in cable insulation or into the cable core through diffusion may compromise adjacent connectors or terminal equipment not designed to withstand moisture. This vulnerability has not been addressed.

Peer Review Comments:

a. I disagree. Cable qualification testing addressed this.

b. I agree partially. It deserves some attention in the ongoing literature survey that is being done under contract for the NRC. If the scores of cable testing performed to date indicate that moisture intrusion through cable insulation is a high probability event, we should perhaps initiate additional research on cable connections. I am familiar with a couple of instances of such occurrences, but need more confirmation. I have also heard of others, e.g., committee members in the IEEE-383 working group and qualification specialists, mention that cable connections may be the weakest link in the cable systems.

c. This is a valid issue.

d. The information about moisture transmission into equipment has been addressed and was passed along to the industry in EPRI NP-5000, "Handbook on Electrical Interface Sealing," 1988.

e. Industry responsibility; merits analytical resolution and perhaps more NRC oversight may be needed. It is primarily the responsibility of industry to uncover the conditions described in

this statement, but the process could be aided by guidance and increased oversight from the NRC.

f. This is the type of situation that preaging is supposed to address. If equipment is properly preaged prior to LOCA testing, cracking should occur during the accelerated aging process that simulates the cracking that occurs during the installed life of the cable, thereby exposing the vulnerability. On the other hand, if you are referring to equipment qualified under the requirements of the DOR Guidelines where preaging did not take place, then you are correct.

Staff Assessment:

The NRC staff agrees with the view (stated above) that this concern should be reviewed in light of the ongoing literature survey that is being done under contract for the NRC to determine to what extent a significant problem may exist. Also see the previous staff assessment (above).

3. Solenoid valves may not be sufficiently qualified for certain applications.

Peer Review Comments:

a. There is no evidence of this at this time.

b. I disagree. I am not aware of any such inadequacy. Having said that, let me also mention that there is certainly room for improvement in future qualification tests. Ongoing industry group qualification programs for certain SOVs do address some of them [applications].

c. Considerable effort has been dedicated to solenoid valve qualification. The qualification of solenoid upgrades is currently being accomplished in industry.

d. Industry responsibility; more NRC oversight may be needed.

e. This may be correct, but we need to discuss specific applications.

Staff Assessment:

This concern should be reviewed in light of the ongoing literature survey that is being done under contract for the NRC to determine to what extent a significant problem may exist. Corrective action should be taken depending on the nature of the deficiencies that are identified (should any exist). Beyond this, focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct EQ deficiencies (see Section A and Section B of this appendix) will help assure that problems of this nature are identified and corrected.

4. EQ barrier elements may not be adequate.

Peer Review Comments:

a. I am not aware of this issue.

b. I agree. This is a valid concern, but is not one that could be resolved by additional research. It should be addressed through plant configuration control programs.

c. This statement is not clear.

d. The information about moisture transmission into equipment has been addressed and was passed along to the industry in EPRI NP-5000, "Handbook on Electrical Interface Sealing," 1988.

e. This may be correct, but whether they are qualified or not depends on the specific application(s). This comment seems to be more plant specific than general and is representative of application problems that must be addressed by the users. EQ barrier elements are capable of being qualified for some application(s); but it should not be assumed that they are qualified for all applications. If these barrier elements are being used in applications for which they are not qualified, it is a violation of the EQ rule and should be addressed by the user and the NRC.

Staff Assessment:

EQ barrier elements consist of flood barriers, walls, enclosures, penetrations, seals, etc., that provide protection against adverse environmental consequences. To the extent that EQ barrier elements are credited, the equipment that is being protected by these elements is not required to be qualified. While this concern deals primarily with leak-tight enclosures, it is not meant to be exclusive of other EQ barriers. See the staff assessment of E.1, E.2, and E.3 (above).

5. Qualification of equipment seals and vapor barriers on plants, especially those that are subject to the DOR Guidelines and NUREG-0588, may not be sufficient.

Peer Review Comments:

a. There is no evidence of this at this time.

b. I know of no basis for this concern.

c. This statement is not clear.

d. EPRI NP-5000, "Handbook on Electrical Interface Sealing," 1988; EPRI NP-6731, "Guide to Optimized Replacement of Equipment Seals," March, 1990; and EPRI NP-6408, "Guidelines for Establishing, Maintaining and Extending the Shelf Life Capability of Limited Life Items (NCIG-13)," May, 1992 have been made available to the nuclear industry.

e. Industry responsibility; more NRC oversight may be needed.

f. This may be correct, but whether they are qualified or not depends on the specific application(s). This comment seems to be more plant specific than general and is representative of application problems that must be addressed by the users. Equipment seals and vapor barriers are capable of being qualified for some application(s); but it should not be assumed that they are qualified for all applications. If equipment seals and vapor barriers are being used in applications for which they are not qualified, it is a violation of the EQ rule and should be addressed by the user of these materials and the NRC.

Staff Assessment:

See the previous staff assessment; this is a subset of the concern expressed by E.4 (above).

6. Epoxy compound used for potting electrical penetrations may not be qualified to the temperature conditions that are experienced post-LOCA and/or during a MSLB.

Peer Review Comments:

a. There is no evidence of this at this time.

b. I know of no basis for this concern.

c. Potting compounds in penetrations should have been qualified as part of the penetration. If not, it is most likely a vendor specific or model specific problem.

d. Industry responsibility; more NRC oversight may be needed.

e. This may be correct, but whether it is qualified or not depends on the specific application(s). This comment seems to be more plant specific than general and is representative of application problems that must be addressed by the users. Epoxy compound is capable of being qualified for some application(s); but it should not be assumed that it is qualified for all applications. If epoxy compound is being used in applications for which it is not qualified, it is a violation of the EQ rule and should be addressed by the user and the NRC.

Staff Assessment:

This concern should be reviewed in light of the ongoing literature survey that is being done under contract for the NRC to determine to what extent a significant problem may exist. Corrective actions should be taken depending on the nature of the deficiencies that are identified (should any exist).

7. Use of the following products in EQ applications may need to be better defined and justified:

- polyimide insulation (Kapton)
- Butyl rubber insulation
- mineral wool insulation (especially in wet environments)
- bonded jackets
- coaxial cable
- terminal blocks

Peer Review Comments:

a. True - especially for butyl if used at a plant entertaining life extension.

b. I know of no basis for this concern.

c. I am not clear what the problems are with the listed materials. Define the problem.

d. No material should be used unless it has been qualified in its application. All of the items listed have had specific qualification tests performed on them.

e. Industry responsibility; merits analytical resolution.

f. This may be correct, but whether these materials are qualified or not depends on the specific application(s). This comment seems to be more plant specific than general and is representative of application problems that must be addressed by the users. All of these materials are capable of being qualified for some application(s); but it should not be assumed that they are qualified for all applications. If these materials are being used in applications for which they are not qualified, it is a violation of the EQ rule and should be addressed by the user of these materials and the NRC.

Staff Assessment:

This concern should be reviewed in light of the ongoing literature survey that is being done under contract for the NRC to determine to what extent a significant problem may exist with any of these materials. Corrective actions should be taken depending on the nature of the deficiencies that are identified (should any exist). Beyond this, focused attention on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct EQ deficiencies (see Section A and Section B of this appendix) will help assure that EQ deficiencies are identified and corrected.

8. The color of insulation material may have an influence on the rate of its degradation.

Peer Review Comments:

a. I am not aware of this issue.

b. I know of no basis for this concern.

c. This is a valid concern.

d. Insulation color differences in rate of degradation is probably another second order effect which is overwhelmed by the severity of the DBA testing.

e. Merits analytical resolution.

Staff Assessment:

To the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct EQ deficiencies (see Section A and Section B of this appendix), concerns such as this one are of minor importance.

Summary

Equipment-related issues and concerns should be assessed primarily through review of existing information and by taking full advantage of operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information on an ongoing basis. Corrective actions should be taken as appropriate for significant issues that are identified. Equipment items and concerns that require further review and assessment by the staff in this regard include:

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

The NRC staff did not consider any of the equipment-related issues to be immediate safety problems.

F. NRC Oversight

1. The prescriptive regulatory approach that has been taken relative to EQ is counterproductive, inhibiting progress and innovative approaches in resolving this complex issue.

Peer Review Comments:

a. The regulatory approach taken was driven, to a large extent, by the lack of attention by the industry on this issue. Therefore, I disagree.

b. Can those of us who kept plants operating while we performed EQ inspections hope to be "paroled" someday? This comment reflects how the NRC operates.

c. I agree. There is some validity to this concern. It should be noted that despite this, there have been several innovations on EQ problem resolutions. My guess is that the industry will not, and generally has not, sat idle if there are cost savings to be had through innovations. No research work is needed on this topic.

d. Merits analytical resolution. NRC regulations do allow deviations from prescribed requirements pro[illegible] they are justified. However, the industry usually finds it easier to follow an approach known to be acceptable instead of undertaking the risk of justifying an innovative approach. Perhaps, the NRC should facilitate the introduction of innovative approaches by encouraging them and providing a more efficient process for their review.

e. Perhaps, but the prescriptive regulatory approach resulted from a lack of initiative by the industry, and the out-right resistance by industry to the NRC initiative to address EQ. This can be seen in the industry response to IE Circular 78-08, IE-Bulletins 79-01, 79-01A, and 79-01B and its supplements. Ultimately, the NRC was sent a "Petition for Emergency and Remedial Relief" by the Union of Concerned Scientists (UCS). The petition sought action in two areas: fire protection for electrical cables, and environmental qualification of electrical components. The petition asked the Commission to immediately shut down all operating plants, and to halt construction of new plants. As a result, the Commission issued a Memorandum and Order (CLI-80-21) dated May 27, 1980, which ultimately lead to the prescriptive regulatory approach (through documents such as the DOR Guidelines, NUREG-0588, IEEE Standard 323-1974 and 10 CFR 50.49). I would like to emphasize here that the NRC's approach resulted from industry's refusal to be cooperative after repeated requests from the NRC.

Staff Assessment:

In general, prescriptive regulations do not allow for innovation and advances in the state of technology and tend to be counterproductive.

The NRC staff should encourage industry initiatives to improve the state of equipment qualification, and changes in the regulation (10 CFR 50.49) should be made to facilitate this approach. Specific methodologies, approaches, techniques, and details that are acceptable to the NRC staff for establishing and maintaining EQ should be provided through the issuance of 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.

2. The safety-significance of EQ issues is not differentiated and recognized in the regulatory process. For example, the EQ inspections of the mid-1980s emphasized documentation, without a corresponding emphasis on the equipment's safety significance.

Peer Review Comments:

a. I disagree. The documentation findings were associated with equipment identified by the licensee as being relied upon to function during/following a DBE. This put EQ equipment in a separate safety classification from that normally identified as safety related.

b. I disagree strongly. The licensees set functional performance criteria reflecting necessary safety functions. The numerous complaints about documentation invite the rebuttal: what do you want instead?

c. Human endeavors are subject to human failings. The emphasis on documentation cited in the example is a poor one. One should recognize that the NRC inspections were conducted when the work on implementing EQ was moving full speed ahead. At that juncture, the only form of objective evidence available was documentation. Even then, the NRC did conduct facility walkdowns to review equipment installations, and identified deficiencies. Subsequent inspections at the plant sites and vendor facilities have focused on hardware installation and maintenance, and test equipment problems. One will never know, and most likely will not want to find out, if the real safety benefits of EQ are achieved. With that said, let us now look at how to improve attention to safety significance. The answer is PSA. Absent a systematic effort of that type, we can only have conjectures, and honest professional disagreements on this issue.

d. The issue is not clear; it is not clear what is meant by the safety-significance of EQ issues. Does it refer to the different contributions to risk of different equipment items? Does the statement imply that there should be different levels of safety instead of just Class 1E? (Note: The emphasis on documentation in the mid-1980s was necessary, because it was not feasible at that time to review EQ programs without at least adequate documentation.)

e. It has been determined by the Commission that because all EQ issues are important to safety, for regulatory purposes all EQ

issues have similar safety significance. This approach is reflected in the issuance of Generic Letter 88-07 where in its enforcement the staff was not required to determine the safety significance of each violation of the EQ rule, but rather, was required to aggregate the number of violations and base its findings on an assessment of the significance of the aggregate.

Staff Assessment:

The evolving enforcement policy relative to EQ indicates that there is some degree of truth to this concern. The staff agrees with the view (stated above) that PRA may help to place EQ issues in proper perspective. The NRC staff should be supportive of industry initiatives for using PRA and other techniques to better focus EQ requirements and for placing EQ issues in proper perspective.

3. Given the state of the art that was in existence at the time IEEE 323-74 was developed and the limitations that existed, it would seem that EQ program requirements may have been misdirected (especially with regard to the required determination of "qualified life" and the absence of surveillance requirements for obtaining advance warning of significant degradation).

Peer Review Comments:

a. I disagree.

b. I agree. The concept of "qualified life" should be eliminated altogether, and emphasis should be placed on surveillance, maintenance and condition monitoring.

c. The concept of qualified life has merit in many respects, not the least of which, is the impact on knowing which safety systems are being relied upon for plant operation. The attainment of qualified life is highly probable unless there is a flaw in the original assumptions. By concentrating effort to monitor equipment's condition, these flaws, if they exist, could be detected. The monitoring of equipment condition provides continued assurance that the qualified life is obtainable when no deterioration is found and provides necessary feedback and corrective action opportunities when unanticipated degradation is found.

Non-intrusive surveillance for obtaining advanced warning of significant degradation and the performance of component root cause failure analyses for obtaining the information on actual equipment degradation, are activities which promise both safety and economic payback.

d. The NRC staff does now and always has insisted that licensees and applicants include surveillance and maintenance as part of their EQ programs. In fact, the staff considers an EQ program without a surveillance and maintenance component to be unacceptable. However, the surveillance and maintenance insisted upon by the staff are minimum levels of acceptance, licensees are not

restricted to these minimum levels and are encouraged to develop more comprehensive programs. As you have implied, the Commission has adopted IEEE 323-1974, and for the most part, considers it to be an acceptable method of complying with the requirements of 10 CFR 50.49. IEEE 323-1974 also provides a minimum acceptable level of compliance, and licensees are not forbidden to go beyond its limits when developing EQ programs. As for the requirement of determining a qualified life, to date neither industry nor the NRC has found a more acceptable substitute for determining the reliability of electrical equipment important to safety installed or to be installed in Nuclear Power Plants.

e. Merits analytical resolution. The requirements of IEEE Std 323-74 were not necessarily misdirected; they were the best that the industry consensus could produce at that time. However, we have gained much experience in the two decades since then, and it is important to incorporate current knowledge in a revision of qualification requirements. The following additional views ware also expressed in response to other related issues and problem statements:

- More effort should be directed toward applying the lessons learned during the last two decades to modify qualification requirements to resolve the problem of demonstrating a meaningful qualified life [re: age conditioning].

- One alternative to the requirement for qualified life is the use of stress testing prior to LOCA testing and enhanced condition monitoring in service [re: state of art capabilities].

- The issue emphasizes the point that has been made by several other issues and problem statements that an effort is needed to replace qualified life as a major element of EQ [re: equipment aging].

- Operating experience and enhanced condition monitoring are among the alternatives that should be considered in lieu of a qualified life [re: scheduling EQ repetitive maintenance].

- The effects of installation, maintenance, and surveillance practices have been addressed only cursorily in industry standards and regulatory guides and it would be helpful if the NRC provided more detailed guidance than is currently available [re: effects of installation, maintenance, and surveillance practices].

- The suggestions (made in response to other issues and problem statements) that EQ requirements be reviewed in light of the experience of the last two decades has the prospect of increasing the assurance of safety and reducing EQ costs [re: tight budgeting].

Staff Assessment:

Given the shortcomings and uncertainties that exist relative to "qualified life," failure of the NRC staff to recognize the need for focused attention on maintaining continued qualification over the installed life of the equipment, and failure of the staff to justify multiple EQ standards supports the contention that NRC efforts were somewhat misdirected. However, a lot of good technical work has been done both by the nuclear industry and by the NRC, and the NRC staff agrees with the view (stated above) that it is important to incorporate current knowledge that has been gained over the last two decades in a revision of the existing qualification requirements. The NRC staff should be supportive of industry initiatives in this regard.

4. A lot of research has been completed and much more experience has been obtained in the area of EQ since 10 CFR 50.49 was issued, but focused NRC programs and initiatives apparently do not exist to continually monitor progress in this area and to make use of this information for restructuring, directing, and improving EQ program requirements.

Peer Review Comments:

a. I agree. The ongoing literature review that is currently being performed under contract to the NRC should take care of this concern.

b. Merits analytical resolution (see comment "d" of the previous concern).

c. I disagree with this statement. The NRC sponsored a significant portion of the research conducted in this area, and uses both the results of that research and all applicable experience obtainable in an effort to improve EQ program requirements while maintaining minimum acceptable levels of compliance that will insure high levels of safety.

Staff Assessment:

This is a valid concern. However, except for situations where current EQ practices are perceived to be lacking or inadequate, it is primarily the responsibility of the nuclear industry to identify improvements and alternatives that are desirable and technically justified. Nonetheless, the NRC staff should catalogue and be familiar with the advances that are being made, and maintain cognizance and expertise in the area of EQ. Further, the NRC staff should encourage and be supportive of industry initiatives to improve EQ methods and practices based on new developments and advances that are being made.

5. NRC research activities have not been entirely successful in resolving the "age-old" EQ issues that were initially identified (see the summary of NUREG/CR-4301 in Appendix L of the staff's report that addresses EQ-TAP Action Item 3.d for specific examples).

Peer Review Comments:

a. I am not aware of this issue.

b. I agree. The ongoing literature review that is currently being performed under contract to the NRC should take care of this concern, at least partly.

c. Merits analytical resolution. The correctness of this statement emphasizes the point that research advances slowly within the limitations of funding, facilities, and qualified researchers. This recognition should be taken into account in the planning of new research programs and the allotment of resources thereto. The statement also supports this reviewer's sparing use of the "Merits Experimental Research" comment.

d. If success is measured only in terms of resolving old or existing problems, then you are correct. However, research that does not provide solutions to old problems can and often does provide new information about existing problems or products. The NRC research activities have been more successful in providing new information and in identifying previously unknown limits in component capabilities.

Staff Assessment:

Research is good to a point, but there are limitations to what can be accomplished. The results of past research efforts should be catalogued and the information should be well understood and related to specific equipment applications, as appropriate. Any further research should: a) be based on a well defined need for additional information, b) be pursued only if there is a good likelihood that the desired information will be obtained, and c) be pursued only if the cost of research is justified in terms of the expected benefit to public health and safety.

6. NRC reporting requirements for EQ-related problems (i.e., problems that occur during qualification testing as well as problems that occur during plant operation) may not be sufficient for establishing an appropriate level of oversight.

Peer Review Comments:

a. I am not aware of this issue.

b. I disagree. If the 10 CFR 50.72, 73 and Part 21, requirements are inadequate for this, I don't know what else can be. If my understanding is correct, there are ongoing efforts by the NRC and the industry to streamline these reporting requirements either because they are unnecessary, or duplicative, or burdensome.

c. Merits analytical resolution; more NRC oversight may be needed. This statement is consistent with the common observation that information in industry and NRC data bases (such as LERs) is not only deficient but can be misleading.

d. Reporting requirements are in accordance with 10 CFR Part 21. If this statement is suggesting that 10 CFR Part 21 is inadequate, then specific examples should be cited. The NRC staff is available to discuss any shortcomings, including additional oversight.

Staff Assessment:

There is a large degree of uncertainty inherent in the EQ process that must be recognized and compensated for. For example, qualification testing typically does not involve a large enough sample size to be statistically significant (in fact, qualification may be based on the test results of a single unit), and how equipment will actually age in a nuclear power plant environment is largely a matter of speculation. By understanding and resolving equipment problems that arise during plant operation, much of the uncertainty inherent in the EQ process can be compensated for. Therefore, special consideration should be given to EQ reporting requirements; a low threshold is necessary for reporting of EQ deficiencies so that the staff will be cognizant of EQ problems that are being identified and better able to recognize and resolve emerging EQ issues.

7. Justifications for continued operation (JCOs) allowed under Generic Letter 88-07 may not be appropriate.

Peer Review Comments:

a. There is no evidence of a problem here.

b. I disagree. This is not an EQ issue that requires further research focus. It is an industry house keeping issue.

c. That is correct.

Staff Assessment:

The intent of the JCO process was to provide an interim period of relief when appropriate to allow licensees to establish qualification during instances when equipment qualification is found to be deficient. The JCO process outlined by GL 88-07 allows licensees to "make a finding of operability using analysis and partial test data to provide reasonable assurance that the 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, the JCO is a temporary measure and a long-term solution that complies with the EQ rule must ultimately be implemented. This aspect of the JCO appears to be reasonable given the circumstances and uncertainties relative to EQ in general. The one issue that still needs to be addressed is that the process does not recognize the need for an exemption from the EQ rule per 10 CFR 50.12.

8. Differences in individual NRC inspector's EQ knowledge level and inconsistent interpretation of EQ requirements have a severe impact on licensees' EQ programs.

[It was suggested that the NRC should perform technical reviews and issue safety evaluation reports (SERs) for each qualification test report issued by a vendor or original equipment supplier, so that licensees would know which test report is considered valid and acceptable to the NRC for equipment qualification.]

Peer Review Comments:

a. I agree regarding impact of NRC inspectors that have varied experience levels.

b. I agree. All human endeavors are subject to human failings. Maybe there is room for improvements in this area. Perhaps the NRC should consider additional training for inspectors, preferably by someone from outside the NRC with knowledge about industry programs.

The second item regarding technical evaluation of test reports, it's a bad idea. Will this not lead to a false sense of security amongst the licensees? Never let it be forgotten that the licensee is responsible for the safety of the plant, and will pay the price in the end, not only for the NRC review, but also for any undesirable consequence therefrom.

c. The same could be said of all inspections, not just EQ.

d. During the 1980's significantly more NRC and industry personnel were regularly attending EQ training courses. These training courses did provide the basics for a minimum understanding and provided a forum for discussion of latest developments.

e. Merits analytical resolution. There have been instances in which NRC staff members have been assigned to EQ activities, although they had no prior familiarity with the subject. The NRC should assure that inexperienced staff are not put in the position of making safety decisions before they are adequately trained.

The suggestion of technical review of qualification test reports (presumably by qualified staff) merits consideration. While it might not be feasible to review all test reports, it might be feasible to do so on a selective basis: perhaps a few reports in each equipment category. Since a test report might be used for several different applications it would still be the owners' responsibility to confirm that the test report demonstrates that the acceptance criteria of each application are met.

f. First of all, it was the intent of the NRC to be as consistent as possible in the application of the EQ rule. However, we realize that in spite of our best efforts, differences in the application of the rule will sometimes occur. It is our goal however, to restrict these differences to the differences in individual personalities that we all share in our perception of the wo ld we live in.

Second, the idea of reviewing test reports issued by vendors or original equipment suppliers is impractical because EQ is a bit more complicated than that. For example, a test report used to demonstrate acceptable qualification for a particular item to be used in a specific application at site A, may not demonstrate that same item is qualified for a similar application at site B. Consequently, if the NRC issues an SER stating that the item is qualified, both site A and site B will think the item can be used because it was found qualified by the NRC. If on the other hand, the NRC's SER stated that this item is not qualified, site A would be deprived of its use. Therefore, we have the situation that exists today, i.e., qualification is site dependent and licensees are responsible for qualification at their respective sites.

Staff Assessment:

EQ is a very specialized area and requires a certain level of understanding and expertise. While it is not necessary (nor desired) for all NRC field inspectors to be experts in this area, some level of training and qualification is necessary. The NRC Headquarters (HQ) Office should establish and maintain expertise in this area, and resolution of specific EQ problems that are controversial or beyond the knowledge level of field inspectors, should be discussed with the HQ staff. With regard to review of test reports, see the staff assessment of F.9 (below).

9. NRC review and inspection programs relative to EQ have not been adequately maintained. For example:

Peer Review Comments:

a. There is probably some truth to this on all counts cited (below).

b. I definitely agree to the first bullet (below). Not aware of the other issues.

c. The statements that follow are basically true. However, some of the current EQ inspectors did take part in the inspections of the 1980s. In addition, the SRP (including Section 3.11) is in the process of being updated.

Staff Assessment:

The concern is a valid one. At the time that the EQ rule was published and implemented, there was a lot of controversy and uncertainty associated with the qualification methodology that had been approved by the staff, multiple standards existed without technical justification, and information in this area was rapidly evolving. The situation warranted continued focused attention by the NRC staff to catalogue and better understand the information that was being obtained through research activities, and to closely monitor operating plant experience and EQ problems that were being identified so that continuing problems could be recognized and resolved. The NRC staff should establish a more

focused program of EQ oversight by: (a) establishing and maintaining a high level of expertise in the area of EQ; (b) maintaining EQ guidance documents (including the SRP) up to date based on advances that are made through research and industry initiatives; (c) developing and implementing ongoing EQ audit and inspection programs; (d) setting a low threshold for reporting of EQ deficiencies 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 (e) better managing and directing research activities.

- Training/qualification of NRC inspectors and reviewers relative to EQ has not been maintained. The EQ inspections were conducted on a one-time basis and a periodic NRC inspection program has not been established and implemented. Current NRC inspectors are not sensitive to EQ issues, they do not receive training on EQ issues and standards, and they did not participate in the EQ inspections of the 1980s.

Peer Review Comments:

a. I don't doubt it.

b. This reviewer does not know to what extent the statements in this paragraph are true; however, to the extent that they may be true, action by the NRC would be indicated. Also, in response to an earlier issue, the following view was expressed:

> There have been instances in which NRC staff members have been assigned to EQ activities, although they had no prior familiarity with the subject. The NRC should assure that inexperienced staff are not put in the position of making safety decisions before they are adequately trained [re: NRC inspectors' EQ knowledge].

Staff Assessment:

See the staff assessment of F.8 (above).

- The SRP (Section 3.11) is very much out of date and needs to be made current (e.g., the Environmental Qualification Branch is listed as the lead review group; there is no reference to the EQ rule; a "central file" is referred to contrary to what was ultimately required by 10 CFR 50.49; and RG 1.89 and IEEE 323-74 are not recognized as the appropriate staff guidance documents for satisfying EQ requirements).

Peer Review Comments:

a. I agree.

Staff Assessment:

This is a valid concern. See the staff assessment of F.9 (above).

- IEEE Standards 381, 535, 627, 649, and 650 (and perhaps others) pertaining to EQ have not been endorsed by the NRC.

Peer Review Comments:

a. Merits analytical resolution.

Staff Assessment:

See the staff assessment of F.9 (above).

10. The NRC has not provided guidance on how plant data can be used to modify the projected qualified life of EQ components.

Peer Review Comments:

a. I agree.

b. True, but do we really want the NRC to issue such guidance? The licensees should develop one (preferably collectively) and implement them consistently. The NRC's input wouldn't hurt. Maybe IEEE should be called upon to do this expeditiously. Also, see peer review comments elsewhere on totally getting rid of the qualified life concept.

c. Merits analytical resolution. IEEE has initiated an effort to consider preparation of a standard that will address the use of operating experience in qualification.

d. If the qualified life of components has been determined by methods acceptable to both the NRC and industry, and the components in question have reached the end of their qualified lives, there are only two acceptable possibilities: (a) replace the components, and (b) retest the components.

Staff Assessment:

The NRC staff agrees with the view (stated above) that guidance on the use of plant data to modify the projected qualified life of EQ components would best be pursued as an industry initiative. However, to the extent that focused attention is placed on operating plant experience and PRA information, equipment performance, condition and environment monitoring, root cause assessment, and trending of information in order to identify and correct any EQ deficiencies that may exist on an ongoing basis, this concern becomes one of minor importance.

11. Some licensees expressed the view that Information Notice 92-81, "Potential Deficiency of Certain Instrumentation and Control Cables," was not well focused and created confusion.

Peer Review Comments:

a. There is some truth to this. Again, we should never forget that human activities are subject to human failings. Hopefully, we have learned from this.

b. Merits analytical resolution. If confusion exists, there is a need for clarification. Perhaps more importantly, there is a need to answer the questions raised as a consequence of the fact that the Sandia National Laboratories testing applied all irradiation (aging plus accident doses) prior to thermal aging. It has been claimed that this procedure produced much more cable degradation than either the sequence of thermal aging followed by aging-and accident-irradiation or the sequence of aging irradiation, thermal aging, and accident irradiation.

c. Information Notices (including Information 92-81) are provided for the edification of licensees, and do not require a response. However, if the information contained in an Information Notice is applicable to a particular licensee's structures, systems, and components, then that licensee is expected to take corrective actions as necessary to maintain safety in accordance with the requirements of the Code of Federal Regulations. Information Notices are often written in a general form in order to provide affected licensees with the flexibility that may be necessary to minimize the impact of a potential resolution. Specifically, Information Notice 92-81 discussed failures of cable jackets and insulation manufactured by two specific vendors. Plants having these cables in environments represented by the test environments in which the cables failed, should conduct an investigation to determine if (and what) corrective action is necessary and proceed with that action. Finally, Information Notices always provide an NRC technical contact(s). Licensees should use the applicable technical contact to discuss clarification as necessary.

Staff Assessment:

This is a valid concern. While it is important to alert the industry of potential problems with equipment qualification, the NRC staff should take care not to act prematurely before enough is known and understood about the specific problem that has been identified. In the case of IN 92-81, there was some controversy about the aging sequence that was used by Sandia. Also, irrespective of failures, under the accepted methodology a single successful test result provides sufficient basis for qualification and the NRC staff was not clear as to what specific conditions the suspect cables were not qualified for.

12. 10 CFR 50.49 does not define the terms "similar" and "significant" and guidance is needed on how to use these terms.

Peer Review Comments:

a. I am not aware that this is still an issue.

b. See the enforcement files.

c. We can't have it both ways. On the one hand we criticize the NRC for being too prescriptive, and on the other we want to prescribe even ordinary and commonly used terms which, in their usage in EQ context, have none other than their dictionary meaning.

d. An NRC/EPRI dictionary was prepared to provide definitions and agree on terminology.

e. Merits analytical resolution.

f. To date, the NRC staff has interpreted the term "similar" in the context of EQ to mean "the same"; the term "significant" in the context of EQ has been primarily left to the discretion of licensees and applicants.

Staff Assessment:

Confusion of this nature is best addressed through industry initiatives. The NRC staff should encourage and be supportive of such efforts.

Summary

Based on the staff's review of NRC oversight issues, the following recommendations were made:

a. The NRC staff should encourage industry initiatives to improve the state of equipment qualification, and changes in the regulation (10 CFR 50.49) should be made to facilitate this approach. Specific methodologies, approaches, techniques, and details that are acceptable to the NRC staff for establishing and maintaining EQ should be provided through the issuance of 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.

b. The NRC staff should be supportive of industry initiatives to: (a) improve and streamline EQ requirements, methods, and practices based on the knowledge that has been developed over the last two decades; and (b) use PRA and other techniques to better focus EQ requirements and to place EQ issues in proper perspective.

c. The NRC staff should establish a more focused program of EQ oversight by: (a) establishing and maintaining a high level of expertise in the area of EQ; (b) maintaining EQ guidance documents and the SRP up to date based on advances that are made through research and industry initiatives; (c) developing and implementing ongoing EQ audit and inspection programs; (d) setting a low threshold for reporting of EQ deficiencies 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 (e) better managing and directing EQ research activities.

d. The one issue that remains to be addressed relative to JCOs is that the process does not recognize the need for an exemption from the EQ rule per 10 CFR 50.12.

e. EQ is a very specialized area and requires a certain level of understanding and expertise. While it is not necessary (nor desired) for all NRC field inspectors to be experts in this area, some level of

training and qualification is necessary and should be provided. Resolution of specific EQ problems that are controversial or beyond the knowledge level of field inspectors, should be discussed with the HQ staff.

f. Research is good to a point, but there are limitations to what can be accomplished. The results of past research efforts as well as other insightful information relative to EQ should be catalogued and the information should be well understood and related to specific equipment applications, as appropriate. Any further research should: a) be based on a well defined need for additional information, b) be pursued only if there is a good likelihood that the desired information will be obtained, and c) be pursued only if the cost of research is justified in terms of the expected benefit to public health and safety.

g. While it is important to alert the industry of potential problems with equipment qualification, the NRC staff should take care not to act prematurely before enough is known and understood about the specific problem that has been identified.

G. Miscellaneous Peer Review Comments

a. The list appears to have at least two problems. First, it presents both sides of most concerns identified (on the one hand, the old criteria, requirements, methodology were too rigorous, prescriptive, and onerous; and on the other hand, they were not stiff enough). Second, the list doesn't reflect much study of what was done in licensing and operating reactor EQ actions in the 1984-89 time frame. For example, ground rules were documented concerning cold shutdown, the escalated enforcement actions for 30-some plant site inspections introduced considerable consistency with regard to significant violations, and the EQ inspection procedures addressed PRA for the sample selection process.

Here's an example of what has been done. The Franklin TERs of the early to mid 1980s documented EQ reviews for all of the master list equipment at all of the operating reactors. During the EQ inspections, we found good and bad aspects, including the failure of many licensees to identify all equipment requiring qualification, and we built on the foundation of the TERs. One of the strong points of the TERs was that they addressed the plant functional requirements for <u>each</u> component; the component had to be shown to be capable of performing specified functions for a specified environment (i.e., don't ask me if it's qualified, ask me what it's qualified for). It wasn't over-simplified generic analysis, it was real world. The Franklin TERs weighed several hundred pounds. Was the information in them evaluated as part of formulating the present list? Some of the criticisms might read differently if they were.

b. It's too bad that EQ was consigned to limbo for so many years prior to the present resurrection. Continuity was pretty thoroughly disrupted, and those of us who plowed thousands of hours into EQ in the 1980s have discarded and forgotten considerable information that might be useful now.

April 8, 1993

MEMORANDUM FOR: Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

THRU: William T. Russell, Associate Director
for Inspection and Technical Assessment
Office of Nuclear Reactor Regulation

FROM: Ashok C. Thadani, Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: RISK IMPACT OF "OLD" ENVIRONMENTAL QUALIFICATION (EQ) REQUIREMENTS FOR ELECTRICAL EQUIPMENT AT OPERATING NUCLEAR POWER PLANTS

In response to your request, the Probabilistic Safety Assessment Branch (SPSB/DSSA) performed a preliminary risk analysis to quantify the risk impact of electrical equipment qualified under the "old" EQ requirements (i.e., DOR Guidelines or NUREG-0588 Category II requirements). Due to limitations in current PRA models and data, a screening evaluation was perfo-med. The scope was limited to core damage prevention and in-containment electrical components.

Plant specific analyses were performed for two PWRs (Sequoyah and Surry) and one BWR (Peach Bottom). The results of these preliminary analyses indicate that the risk impact of "old" EQ requirements is plant specific and could be significant. For an accurate quantitative assessment a more detailed risk analysis is required. Details are included in the enclosed report.

Should you have any questions regarding this preliminary risk analysis, or need additional information, please contact Nick Saltos of my staff at 504-1072.

Original signed by A.C Thadani

Ashok C. Thadani, Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: w/enclosure
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L. Kokajko
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